Issued March 25, 1914.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE UNIVERSITY OF MISSOURI AGRICULTURAL EXPERIMENT STATION. F. B. MUMFORD, DIRECTOR.

SOIL RECONNOISSANCE OF THE OZARK REGION OF MISSOURI AND ARKANSAS.

BY

CURTIS F. MARBUT,

In Charge of Soil Survey.

[Advance Sheets—Field Operations of the Bureau of Soils, 1911.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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BUREAU OF SOILS.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., May 29, 1913.

SIR: During the field season of 1911 soil-survey work in Missouri, which is being carried on in cooperation with the State officials, was continued by the completion of a reconnoissance survey of the Ozark region. To make the work comprehensive it was extended to cover the country of similar characteristics in Arkansas. This is a region of varied topography, much of it steep and rocky and little suited to general farming, but there are included wide areas of smoother surface and of good agricultural types of soil. The region has been exploited and widely advertised as a fruit-growing section, and so far as the soils are concerned it seems well adapted to this industry; but fruit growing has not been as successful as might be expected, owing to the frequent occurrence of erratic frosts, and it seems probable that the future development of the region will depend upon the introduction or the development of other lines of agriculture. Dairying, already carried on in parts of the Ozark, may well be extended, and stock raising and general farming should find an increasingly important place. Many of the soils are of limestone origin, and therefore well adapted to the production of grasses and forage crops.

I have the honor to transmit herewith the manuscript report and map covering this area and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1911, as provided by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

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SOIL RECONNOISSANCE OF THE OZARK REGION OF MISSOURI AND ARKANSAS.

By CURTIS F. MARBUT.

THE OZARK REGION.

The term Ozark as here used is applied to an area of elevated country lying in Missouri, Arkansas, and Oklahoma and small areas lying in adjacent portions of Illinois and Kansas.

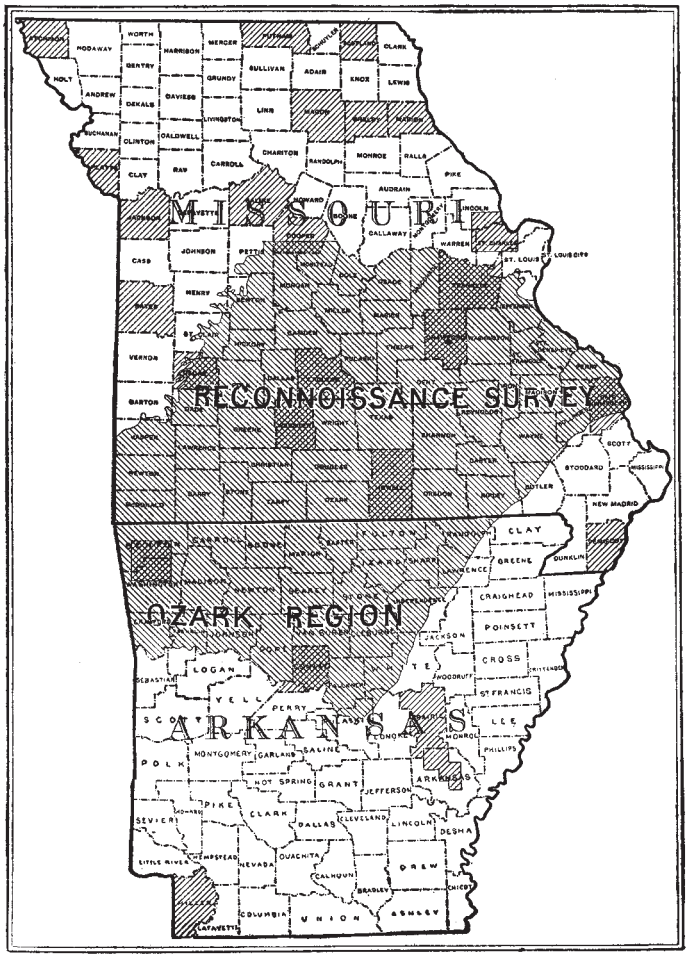

FIG. 1.—Sketch map showing areas surveyed in Missouri and Arkansas.

In Missouri and adjacent portions of all the other States mentioned it is an elevated limestone region, its northern boundary lying

approximately along the Missouri River, its eastern boundary along the Mississippi, and its western boundary along a line running from Boonville, Mo., to the northwest corner of Jasper County, Mo.

In Arkansas it includes a limestone region and a sandstone-shale region. The limestone region lies as an east-west belt of country extending from the northern boundary of the State, where it is continuous with the same character of country in southern Missouri, southward to a general line running from a few miles north of Fayetteville eastward to Batesville. South of this line the sandstone-shale region includes all that part of the State lying west of the Mississippi lowlands and north of the low sandy region known as the Coastal Plain. In Oklahoma it includes only the hilly and mountainous part of the State along its eastern border; in Kansas it includes only the extreme southeastern corner and in Illinois only a narrow belt along the Mississippi River south of St. Louis.

General Description of the Subregions.

The region as a whole consists of three main subdivisions or belts of country, each with a characteristic expression, differing from either of the others. They are: (1) The Ozark Dome, (2) the Boston Mountain Plateau, and (3) the Ouachita Mountains (fig. 2).

OZARK DOME.

The Ozark Dome is an elevated region known as the Ozark Mountains, the Ozark Plateau, or the Ozark Hills. As a whole it is topographically an elongated dome. Its axis lies in a northeast-southwest direction, its eastern end lying approximately on the Mississippi River about 50 miles south of St. Louis and its southwestern end in northeastern Oklahoma. Its eastern boundary, so far as this report is concerned, is the western side of the Mississippi Valley and the western side of the lowland region of southeastern Missouri and northeastern Arkansas. Its southern boundary runs across northern Arkansas from Batesville on the east through Fayetteville to the State line in the northwestern part of Washington County. Its western boundary extends from the western part of Cooper County, Mo., southwestward across the Missouri-Kansas line near the northwestern corner of Jasper County, Mo., and joins the southern boundary in northeastern Oklahoma. Its northern boundary lies a few miles north of the Missouri River. This report covers only that part of it lying south of the river.

BOSTON MOUNTAIN PLATEAU.

The Boston Mountain Plateau is an elongated block of highland lying in a southeast-northwest position, its eastern end lying along the

western boundary of the Mississippi lowlands in Independence and White Counties, Ark., and its western end extending into eastern Oklahoma. It lies between the White and Arkansas Rivers, the greater part of it being drained to the latter stream. It includes the northern part of the sandstone-shale region referred to above.

OUACHITA MOUNTAINS.

The Ouachita Mountains lie south of the southern slope of the Boston Mountain Plateau, and include all that part of the State

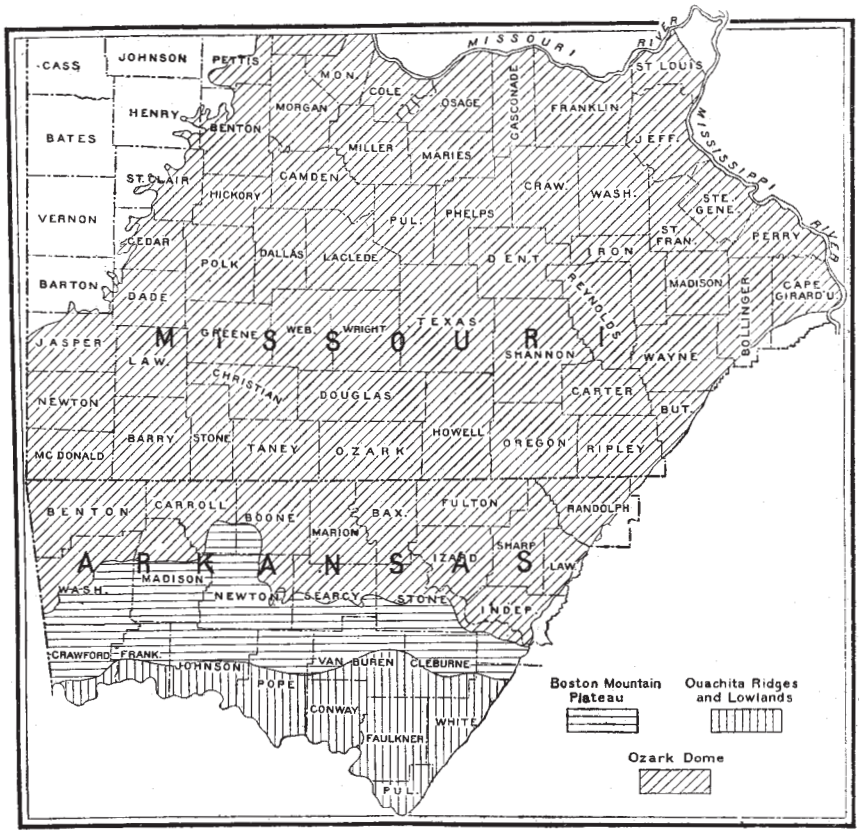

FIG. 2.—Sketch map showing the extent of the several more important physiographic divisions of the Ozark region.

bounded by the plateau on the north, the White River lowland on the east, and the Coastal Plain on the south. They consist of alternating narrow east-west ridges separated by broad lowland belts with occasional isolated areas of flat-topped plateaus, none of the latter, however, reaching the elevation of the Boston Mountain Plateau.

General Geology

THE ROCKS.

The soils of the Ozark region are residual. They have been made of material derived from the rocks on which they lie or from rocks that lay not far above the existing rocks. The soils are very closely related to the rocks therefore and vary with them. A proper grasp of the character and relationships of the soils can be obtained only through an understanding of the character of the rocks and of their relations to each other in space.

Three great groups of rocks occur in the region. Each group occurs exclusively or predominates in some particular part of the region.

The Ozark Dome contains an area of each of two of these groups, while the third group occupies the areas of the Boston Mountain Plateau and the Ouachita Mountain belt. The three groups of rocks are (1) the group of igneous rocks, (2) the group of nonfragmental rocks, and (3) the group of fragmental rocks. The rocks of the last two groups are bedded, and those of the first group are massive.

Agriculturally the igneous rocks are of very little importance. They occur in a very hilly region, known as the St. Francis Mountains, practically all of it being too rough to cultivate. Over the greater part of the area the soil cover is very thin and full of stones, and the bare rock is exposed over considerable areas. The rocks are chiefly feldspathic, disintegrating into clays. They occur in St. Francois, Washington, Madison, and adjoining counties in Missouri and in small isolated areas elsewhere.

The nonfragmental rocks, consisting of carbonate rocks (limestones, magnesian limestones, and dolomites), dominate the area described in this report as the Ozark Dome. It includes a few thin beds of sandstones and shales and the area of igneous rocks. Both the latter rocks underlie a relatively small area of the Dome. Two areas of sandstones, one in Dent County, Mo., and the other in Izard County, Ark., are large enough to be of importance as soil formers. The area of predominantly fragmental rocks lies wholly in Arkansas and includes the Boston Mountain Plateau and the Ouachita Mountains.

The rocks of each of these areas will be more fully described under the discussion of each area.

THE GEOLOGICAL STRUCTURE.

While the soils as such are determined by the character of the rocks from which they have been derived and the stage of weathering reached, the utilization of the soils is, to a very great extent, determined by the topography of the country in which they occur.

This is a product of the three factors: (1) Character of the rocks, (2) attitude of the rocks, and (3) stage of topographic development reached.

By the expression "attitude of the rocks" is meant what is ordinarily expressed by "geological structure." It applies to the way the rock beds lie underground, whether, for example, they lie essentially horizontal or whether they stand edgewise or plunge slantingly into the earth. In the Ozark region all these attitudes occur, but in by far the larger part of the area the rocks lie so nearly horizontal that the naked eye can discern no slant, though when measured at widely separated points the beds are seen to slant very slightly. In areas of such gentle slant, or "dip," as it is called, the local topography or surface relief does not differ essentially from what it would be if the same rocks lay perfectly horizontal. In the Ozark Dome and the Boston Mountain Plateau the rock beds lie essentially horizontal, while in the Ouachita Mountains they slant downward, usually at rather high angles. Since the area described in this report includes only a small part of the latter region, it is evident that in by far the larger part of the region described the rock beds lie essentially horizontal.

Topography.

The region, as a whole, is an elevated one. It stands higher than any of the immediately surrounding country, except the tops of some of the Ouachita ridges south of the Arkansas River. Only a narrow belt along its eastern and southern borders lies below 800 feet above sea level. The maximum elevation of the Ozark Dome is about 1,800 feet; the average elevation of its crest line is about 1,300 feet, and that of the whole Dome area is about 1,050 feet.

The Boston Mountain Plateau is higher than the Ozark Dome, its maximum elevation being about 2,300 and the average of the whole area about 1,800 feet. It does not slope gradually from its crest line to its boundary like the Ozark Dome, but drops abruptly on its northern side and slopes rapidly on its southern side to the adjacent low land.

That part of the Ouachita region lying north of the Arkansas River is low. Its low-land belts range from 300 to 800 feet, and its ridges and plateaus range from 500 to 1,000 feet in elevation.

The whole region is one that has been subjected to erosion for a long period of time. It is, as a whole, a region of thorough dissection. Only an extremely small percentage of its area can be called smooth. The areas of very soft rock have been worn down to low, smooth country, and the watersheds still preserve in places remnants of an old land surface of smooth contour that antedated the erosion of the existing valleys.

The sketch map (fig. 3) shows the area in which 50 per cent or more of the country is too rough for profitable cultivation and the area in which less than 50 per cent is too rough for cultivation. In the latter area only a small part is as smooth as the prairies of Kansas or Iowa, yet a considerable part is no rougher in topography than a large part of the country in northern Missouri.

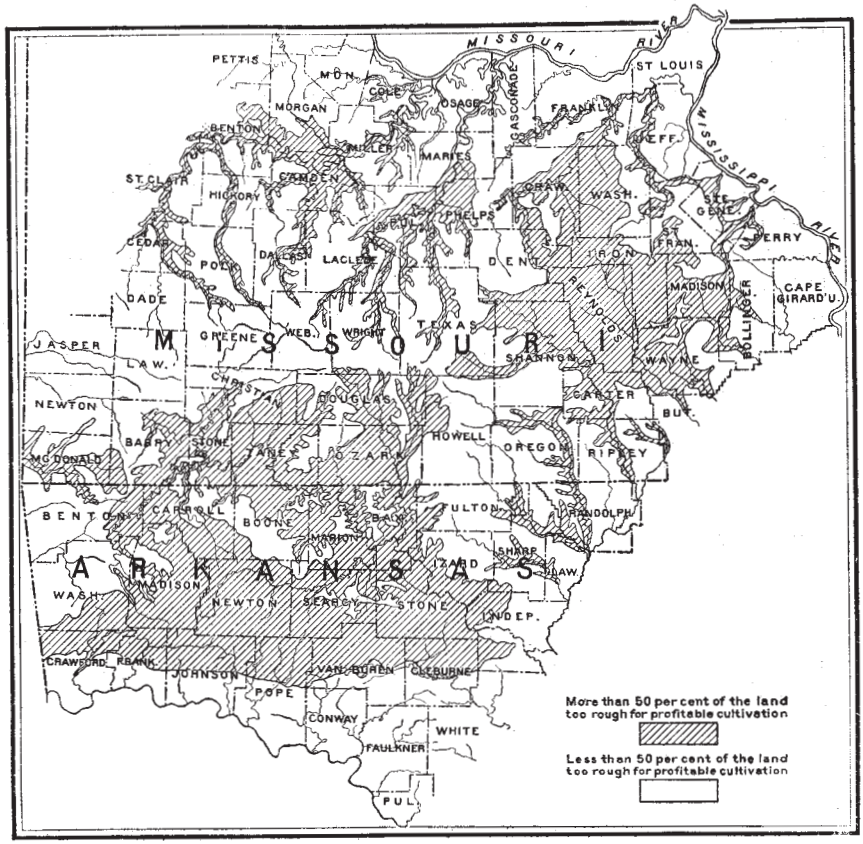

FIG. 3.—Sketch map showing proportion of land well adapted and poorly adapted to agriculture.

CLIMATE.

The northern part of the area covered by this report lies in latitude 38° 30′ and the southern part in latitude 35° 30. It stretches, therefore, across 3°. The whole region lies so far in the interior of the continent that its climate is wholly continental.

The mean annual temperature of the northern boundary is 54.8°, and of the southern it is 60.7°.

The average annual precipitation in the northern part of the area at Jefferson City is 35.01 inches, and in the southern part at Russellville 46.04 inches. The average precipitation during the growing

season, that is from April to October, inclusive, in the northern part of the area is 23.36 inches, and in the southern part at Russellville 28.06 inches.

The average date of the last killing frost in spring at Jefferson City, on the northern boundary of the area, is April 19. The latest date at which killing frost has been known to occur at the same place is May 9. The average date of occurrence of the earliest killing frost in the fall is October 15, and the earliest date at which killing frost has been known to occur is September 29. The average length of growing season in the northern part of the area therefore is 178 days, and the shortest season known to have occurred is 142 days. In the southern part of the area, at Russellville, Ark., the average date of latest killing frost in spring is April 5, the latest date at which killing frost has been known to occur is May 1, the average date at which it occurs in the fall is October 28, and the earliest date of occurrence on record is October 9. The average length of growing season in the extreme southern part of the area is 205 days, and the shortest season known to have occurred is 160 days. Only the low-lying region adjacent to the Arkansas River has a growing season much longer than that of the northern part of the area.

From the foregoing data it is readily seen that the rainfall over the whole area is abundant and usually well distributed. Droughts occur, but they are no more frequent than in other parts of the Prairie and Middle Western States.

The temperature conditions also are favorable to agriculture. The growing season is long enough to mature all the ordinary crops grown in the central part of the United States. In these respects, therefore, the climate is essentially the same as that of the Central Western States.

The following tables show the normal monthly, seasonal, and annual temperature and precipitation at Jefferson City and Springfield, Mo., and at Russellville, Ark.:

Normal monthly, seasonal, and annual temperature and precipitation at Jefferson City, Cole County, Mo.

[Elevation 628 feet.]

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	Inches.	Inches.	Inches.
December	33.8	70	−24	1.94	3.85	1.63
January	30.5	77	−15	2.24	1.60	4.61
February	30.7	74	−25	2.28	2.23	1.70
Winter	31.7	74	−21	6.46	7.68	7.94
March	42.7	93	3	3.04	3.80	6.37
April	54.8	96	21	3.27	2.59	3.94
May	65.5	96	28	4.24	0.65	8.35
Spring	54.3	95	17	10.55	7.04	18.66
June	74.4	105	42	4.37	1.50	5.63
July	78.2	114	51	3.81	1.06	3.97
August	76.7	104	45	2.70	2.12	1.67
Summer	76.4	108	46	10.88	4.68	11.27
September	69.0	104	30	2.83	0.95	6.79
October	56.8	93	22	2.14	1.40	3.89
November	43.9	80	9	2.15	1.21	3.33
Fall	56.6	92	20	7.12	3.56	14.01
Year	54.8	92	16	35.01	22.96	51.88

Average date of first killing frost in autumn, Oct. 15; of last in spring, Apr. 19. Date of earliest killing frost in autumn, Sept. 29; of last in spring, May 9.

Normal monthly, seasonal, and annual temperature and precipitation at Springfield, Greene County, Mo.

[Elevation 1,350 feet.]

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
December	35.5	74	−11	2.50	4.15	3.20
January	31.3	74	−17	2.44	1.82	1.85
February	33.6	76	−29	2.73	0.66	1.15
Winter	33.5	.....	.....	7.67	6.63	6.20
March	43.5	92	3	3.50	1.40	4.76
April	55.7	88	22	4.02	4.25	6.95
May	64.6	89	32	5.86	2.59	8.55
Spring	54.6	.....	.....	13.38	8.24	20.26
June	72.3	96	46	5.28	2.35	15.20
July	76.4	106	53	4.67	1.18	2.45
August	74.8	100	44	4.00	1.50	6.60
Summer	74.5	.....	.....	13.95	5.03	24.25
September	67.9	102	35	3.31	0.68	1.90
October	57.3	90	21	2.96	0.97	7.95
November	44.4	79	6	2.89	4.62	4.75
Fall	56.5	.....	.....	9.16	6.27	14.60
Year	54.8	106	−29	44.16	26.17	65.31

Average date of first killing frost in autumn, Oct. 18; of last in spring, Apr. 14. Date of earliest killing frost in autumn, Sept. 28; of last in spring, May 19.

Normal monthly, seasonal, and annual temperature and precipitation at Russellville, Pope County, Ark.

[Elevation 348 feet.]

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
December	42.3	86	7	2.95	4.41	4.21
January	39.1	78	− 6	3.44	1.71	5.75
February	40.1	82	−15	2.95	1.69	3.48
Winter	40.5			9.34	7.81	13.44
March	52.3	90	15	4.76	6.38	3.99
April	61.8	92	29	3.54	1.85	3.65
May	69.9	97	32	5.55	1.94	10.31
Spring	61.3			13.85	10.17	17.95
June	77.3	104	37	4.17	2.40	6.66
July	81.3	106	56	4.39	3.01	6.39
August	79.7	107	46	3.54	2.24	7.86
Summer	79.4			12.10	7.65	20.91
September	73.4	102	36	4.14	0.89	5.30
October	61.2	92	27	2.73	2.18	2.64
November	49.8	87	14	3.88	2.54	3.45
Fall	61.5			10.75	5.61	11.39
Year	60.7	107	−15	46.04	31.24	63.69

Average date of first killing frost in autumn, Oct. 28; of last in spring, Apr. 5. Date of earliest killing frost in autumn, Oct. 9; of last in spring, May 1.

AGRICULTURE.

HISTORY.

Settlement in the Ozark region began before railways were built into it. The routes by which the earliest settlers reached it were the navigable rivers. While the region with which this report is concerned is surrounded on three sides by navigable streams, there are very few such streams that extend well into it. The Arkansas on its southern boundary, the Missouri along its northern, the Mississippi and White on its eastern boundary furnished easy access to the adjacent border belts, but only two streams that could be navigated even by small boats gave access to its interior. These were the Osage and that part of White River above where Newport, Ark., now stands. Both of these extended into the Ozark Dome and both penetrated no farther than the outer rim even of that part of the region. The whole of the Boston Mountain Plateau region and the entire central portion

of the Ozark Dome were wholly without means of access, Indian trails excepted, until wagon roads had been opened into them.

It was inevitable, therefore, that the Arkansas Valley portion of the Ouachita Mountains and the border belt of the Ozark Dome should be occupied first. The fact that the latter lay adjacent to smooth and accessible portions of the great prairie lowland was another factor favorable to its occupation. It happens also, as will be shown in this report, that the border belt of the Ozark Dome is both smoother and more fertile than the central portion. The influence of all these factors operate in one direction.

The border lands along the Mississippi River were the first to be taken up, large areas of the Hagerstown and Union soils being occupied before the beginning of the nineteenth century. The northern border lands followed next, being settled in the early decades of the nineteenth century. The southern border belt, especially the Clarksville soils in the southwestern part of the region, began to attract attention about the beginning of the third decade of the century. Soon afterwards, however, from the beginning of the fourth decade, the hill people of the southern Appalachian region, those from Tennessee being most abundant, began to settle on the valley lands of the central part of the Ozark Dome. By the middle of the century eastern Kentuckians and mountain people from western North Carolina, northern Georgia, and northern Alabama began to settle the Boston Mountain Plateau region.

The greater part of the Ozark Dome and large areas of the rest of the region discussed in this report was up to the middle of the nineteenth century a region of open woods, large areas being almost treeless. Except on the roughest land, the thoroughly dissected portions of the Clarksville soils, the rough stony land, the Decatur soils, and the more hilly portions of the Boston Mountain Plateau, the timber growth was not dense enough to hinder in any way the growth of grass. The whole region in its vegetation was more closely allied to the western prairies than to the timber-covered Appalachians. There were, however, no large areas of country so entirely bare of trees as to interfere with the settlement of the country. Along all the permanent streams, occupying usually the whole of the alluvial belts, there was commonly a heavy growth of timber. This combination of fertile and stone-free alluvial soil and abundant water and timber attracted settlement to the valleys.

Between the valleys of the Ozark Dome lay originally the remnants of a former rather smooth plateau. Adjacent to the large streams it was thoroughly cut to pieces by the innumerable small valleys, hollows, and ravines that opened into the main valley. Along the main watershed was a belt of smooth country, considerable areas having a

lower local relief than portions of northern Missouri or Iowa. The width of the smooth belt varied with the size and distance apart of the main streams. In general, however, it was greater in the west-central and southwestern portion of the region than on the northern or southern or east-central parts of the region. They were narrowest in the region of Clarksville soils and broadest in those of the Berryville and Springfield soils. The thoroughly dissected belts were often timber-covered and always supported a somewhat scattered growth of trees. The smooth watershed ridges were rarely covered with timber and were often treeless.

In none of the Dome region except the very hilly portions and the alluvial valleys was timber growth dense enough to interfere with an abundant growth of grass. The native "bluestem" wild grass covered the region with a heavy growth, and its burning every fall served to kill every seedling tree that had reared its head during the preceding summer. It was only on the main area of Clarksville soil that the original timber growth was heavy, and there is abundant evidence that at least 40 per cent of that area consisted of grass-covered, sparsely-timbered rolling uplands. The greater part of these uplands was too stony to attract settlement as long as more fertile and less stony alluvial lands were available. Large areas were free enough from stone to make cultivation possible or even easy, yet none of them were as fertile as the alluvial lands.

The smoother areas were almost waterless also. There were no surface streams, no permanent springs, and the permanent ground-water level lay always too deep to be reached easily and cheaply by the pioneer settler's well-digging tools. Often it stood more than a hundred feet below the land surface and well below the upper surface of undisintegrated rock. It was necessary to dig deeply after it and in most cases to go well into the solid limestone country rock.

On the alluvial lands, on the other hand, perennial streams and springs were abundant, and where these did not exist the ground-water level stood usually above the rock surface. In the hilly belts adjacent to the river valleys springs were often abundant, but invariably occurred in deep ravines, making access from the upland difficult. This was not a part of the upland, however, that could be cultivated, both on account of the abundant stone in the soil and the roughness of the topography.

The smooth uplands, as stated before, were practically treeless. This of itself was a serious drawback to its agricultural development by the pioneers of half a century or more ago. Fences had to be built before any crop could be harvested. The only fencing material known to the western pioneer up to that time was rails. Even the small amount of timber growing on the smooth uplands was usually unfit for rails. It was too scrubby, tough, and full of knots for easy

splitting, or for splitting at all in some cases. The only rail timber in the country grew on the alluvial lands or on the adjacent hill belts. To haul this timber several miles was a discouraging prospect, to say the least. The character of the soil, the water supply, and the absence of good timber therefore all combined to delay the settlement of these smooth uplands.

Although the pioneer settler in America produced the greater part of his food and clothing, there were some things needed for his existence that he could not produce; these he had to buy. It was necessary, therefore, for him to produce a greater quantity of some things than he was able to consume himself. His distance from market and the absence of water or rail transportation made it impossible to market large quantities of anything that could not transport itself. After the region had become rather well occupied by settlers, and after great cities supplied with rail transportation had grown up around it, the timber of the hilly belts was converted into lumber and railway supplies and floated out of the region on the large streams. The pioneers of the region, however, had no market for this timber, so that it could not be sold to supply the small amount of cash that they needed. The relatively small amount of desirable farm land or grain land, the large amount of grazing land, the relations of water, timber, and desirable land, as well as the relation of the whole area to markets, all combined to restrict the range of possible systems of farming; in fact, only one system was possible if the farmers desired more than the food and clothing that could be produced on the farm.

Live-stock farming was capable of adjustment to all the conditions without exception. Grain and hay could be grown on the alluvial lands for winter feed, while the whole area of upland was available during six or seven months of the year for pasture, the treeless portions for cattle, horses, and sheep, the tree-covered portion for hogs and sheep. It was necessary to grow only grain and hay sufficient to "carry" the animals through the winter. They were prepared for market on the summer pastures in the case of cattle and on the autumn mast in the case of hogs and, to a certain extent, of sheep. A farm of even moderate size on the fertile alluvial lands would produce winter feed for the live stock that would require many times the area of upland pasture for summer maintenance.

Since this report covers an area that ranges through nearly four degrees of latitude and about 2,000 feet of elevation, it is evident that these factors must have had their effect. Nevertheless, this statement of conditions and possibilities is true of the whole region, excepting the Arkansas River lowland portion on the southern border and a narrow belt along the eastern and northern border where water transportation existed and where there was a heavier timber cover. Along the southern border and the southern end of the eastern

border belt cotton growing was permitted by the climate and the Arkansas and White Rivers furnished the possibility of transportation to market.

The state of affairs above described continued as long as undeveloped alluvial land existed in sufficient area to accommodate the increasing population. As soon as this land was all occupied, the surplus population had to leave the region as a whole or begin the settlement of the uplands. The latter event took place largely because of the narrow geographical knowledge of the people. This event inaugurated a change in conditions, mainly of natural conditions that made necessary a change in the farming system. The region was treeless or nearly so, not because the soil and climate were unfavorable to tree growth, but because the annual fires which burned the dry grass every autumn or winter killed the tree seedlings. There were isolated trees in all parts of the region that had escaped in former years capable of seeding a considerable area quickly. As soon as farmers began to build fences, houses, and barns on the uplands they began to control the annual burning of the grass. Young seedlings sprang up as usual, and if not burned for a year or so they were soon large enough to live through the average fire. The increase in population and the consequent increase in live stock probably helped this along by grazing portions of country so close that only a small covering of grass was left to burn in the autumn. The growth of brush spread with great rapidity, every locality being supplied with seed-producing trees of mature age. Within a few years the greater part of the region was entirely covered with a vigorous growth of young trees, mainly oaks. The change began to take place on an important scale immediately after the Civil War. Within 30 years the growth had spread to such an extent that no large areas of treeless grassy plains existed in the region. The last areas to disappear were the areas of thin Berryville soils of northern Arkansas and southwestern Missouri, mainly in Ozark, Taney, and Stone Counties in the latter State, and Baxter and Marion Counties in the former.

Only one result could be expected from this. The tree growth made the growing of grass impossible. Where the small trees were thick enough to shade the ground entirely the grass was completely killed out. Even where it was not entirely killed out it was too thin to produce abundant food for stock. So far as stock food was concerned the country produced much less than formerly because the small area of cultivated land on the uplands produced much less than was produced by the original growth of grass on the whole area. Only a small proportion of the upland was or is even yet cultivated. The killing of the grass was not the direct result of the plowing up of the sod, but the indirect result of the cultivation of a small part of the upland. The summer feed for live stock failed, therefore. At

the present time great areas of woodland support an extremely small number of cattle or sheep. The farmers felt the change in this environment, but they did not arrest it, nor did they undertake in a concerted way to supply the lack of summer pasture brought about by the change. Very little effort was made to seed tame pastures. The land, in the first place, is not adapted to timothy, and that is about the only pasture plant that the farmers knew anything about. There is also no pasture grass that will stand the overgrazing that is usually demanded of it on the soil as it is, without artificial manuring.

A readjustment became necessary. This could take place in several ways. It could take the form of a curtailment of the scale of living to a plane at which income and outgo balanced; it could be effected by adopting other systems of farming that fitted the new conditions, or by abandoning the region entirely for a more favorable one. In the cotton-growing region no readjustment has ever been necessary; now that the boll weevil has appeared it may become necessary.

The curtailment of the scale of living took place in the more distant parts of the region, the rougher parts, and where transportation facilities were absent. In the whole region there was greater attention paid to grain growing, but where no means of transportation was in reach this could bring very little relief. In the Ozark border region, where water and rail transportation was available, grain growing, especially the growing of wheat, became an important industry. The fact that the eastern and northern border of the region lying adjacent to the Mississippi and Missouri Rivers were being rapidly settled by Germans about this time was an important factor in the matter, since these people are natural-born grain growers rather than stock raisers. In the central part of the Ozark Dome, and in practically the whole of the Boston Mountain Plateau, the agriculture has not passed beyond this grain-growing stage combined with the limited stock raising that existing conditions will permit.

It is in this region that abandoned farms exist on every hand. It is much more true of the Boston Mountain Plateau than of any part of the Ozark Dome or of the Arkansas Valley belt. They are abundant also in some of the counties of the southern Dome border, especially those that are thoroughly dissected by the White River drainage and where mining agitation has been going on. Abandonment, however, has not been confined here or elsewhere in the Ozark region to the rough lands. Many of the abandoned farms on the Boston Mountain Plateau are on smooth land, but on land that will not produce good crops of grain nor of tame grass without great care in cultivation and fertilization. In the White River region the mining agitation of a few years ago enabled the owners to sell their land at

a good price. They took advantage of their opportunity, took their money, and joined the rush to the prairies of Oklahoma, the plains of Texas, and the irrigated basins of the far West. In the Boston Mountain Plateau the timber buyers bought the farms for the timber on them, and the former owners went to join the other emigrants from the region. In the central Dome region there has been no abandonment on so large a scale because there has been no opportunity to sell the land for other purposes than farming. The dry year of 1901 caused the abandonment of many small farms, and since that time few of them have been reclaimed and a few others abandoned. Within the latter part of the decade, however, there seems to have been very little change, and at present there seems to bean improvement. In the other areas of abandonment this is not the case.

In the border belt of the Ozark Dome, with the exception mentioned above, the change from the early live-stock farming system to the grain-farming system was effected without any perceptible disadvantage, mainly because of accessible markets and a soil and topography better adapted to grain growing. These parts of the region have had a steady growth in population and wealth, varying somewhat from place to place, but in no place has there been a decline. The most marked advance has been made in the southwestern part of the Dome region. This has been partly the result of a third stage in agricultural development reached in this region, but not yet reached in the rest of the border belt.

Throughout the Ozark region there has never been any abandonment of farms situated on the alluvial lands. These are good grain soils, and for this reason they have increased in value steadily. They are good clover soils, also, and timothy does well on the heavier types. The owners of these lands have been able to maintain a restricted live-stock farming system that has proved to be profitable, combined with grain farming.

The third stage in the agricultural development of the region, referred to above, is the stage of specialized farming. About 20 years ago the officers of the railways that traverse the region began to call attention to fruit growing, There was no discrimination made either as to place or kind of fruit, except that most of the attention was directed to apples and peaches. During the eighties and nineties many thousands of trees were planted, mainly along the railways in the western part of the region, except of course in the cotton-growing country of the Arkansas Valley. The largest areas were planted in southwestern Missouri, south-central Missouri, and adjacent parts of Arkansas, and in northwestern Arkansas. The center of the former area was Greene County. Along the northern, northwestern, eastern, and southern border belts practically no at-

tention was given to the matter except the development of grape growing in the vicinity of Herman, Mo., and the local development in the market-garden region adjacent to St. Louis. There has been relatively little attention paid to fruit growing on the Boston Mountain Plateau. Practically the only development so far, except small plantings for home use, such as are made throughout the region, has been confined to the narrow belt adjacent to the St. Louis & San Francisco Railroad, mainly in the vicinity of Winslow and Mountainburg.

In the whole region except portions of the Howell County area and the south slope of the Boston Mountain Plateau, the peach was soon practically eliminated as an important commercial fruit. It was soon discovered that peaches were in danger of winter killing, and were also very liable to be caught by late spring frosts. On account of this, peach growing, except in the localities mentioned above, is unimportant as a source of income for the region. Apple growing, on the other hand, has not met with such great difficulties, yet it has been demonstrated without any doubt that dependence upon apple growing as an exclusive system of farming is unwise. The use of smudge pots as a means of defense against the destructive effect of late spring frosts may prove effective in some years and in some localities, but conditions existing in the region will always make the results of smudging more or less uncertain. The trees grow rapidly. The fruit seems to develop properly, but the loss of the crop by spring killing is frequent. During the last decade the region as a whole has had few profitable crops. In northwestern Arkansas results have been somewhat better and in nearly every year there has been a small crop. Total failure is rather rare. In some locations, and especially where the orchards have not been given proper attention, the crop is so often a failure that the orchardist does not have confidence enough to provide himself with spraying apparatus or to give his trees the cultivation and pruning necessary in the growing of good fruit.

The orchards located on the slopes of the high parts of the Boston Mountain Plateau, especially on the Winslow soils, and also on some of the high terraces on the northern slope of the plateau are less liable to damage from frost than in other parts of the region.

The growing of strawberries on a commercial scale was developed in the late nineties in two Ozark localities—in the southwestern Missouri part of the Ozark border and the lower south slope of the Boston Mountain Plateau in the vicinity of Van Buren, Ark. The important shipping points in southwestern Missouri are Logan, Marionville, Monett, Pierce City, Sarcoxie, Purdy, Exeter, Washburn, and Seligman. Although the crop is injured occasionally by spring frosts, the industry has been profitable from the beginning,

and is now in good condition, though it has not expanded any for several years. The gravelly and stony loams of the Springfield series, and the stony loams of the Fayetteville series are well adapted to the growing of a fruit that is fine flavored, and stands shipment well. The growing of other small fruits has never been developed to any important extent.

Along with the development of fruit growing, there has been considerable development of tomato growing, but this industry does not seem to be extending at the present time.

The last important step in the agricultural development of the regions was taken a few years ago when the dairying industry was inaugurated. The natural conditions of soil, water, climate, and topography of the Ozark Dome are probably more nearly adapted to this industry than to any other. The soil is a natural clover soil, except where its lime has been thoroughly leached out of it and where its drainage is poor. There are very few square miles in the whole Ozark Dome on which limestone can not be found sufficiently pure to make a good agricultural lime.

The industry could not develop until the facilities for transportation were adequate and markets were available. Neither of these conditions exist over the whole area. It is very probable that there will be many years yet before they will exist in the central Dome region and large parts of the Boston Mountain Plateau. The recent development has taken place mainly in the southwestern Missouri part of the Ozark border. Even where natural conditions, transportation, and markets are all favorable, the industry can not develop where the people are not dairymen, nor capable and willing to become dairymen. The industry has never developed to any important extent either on the eastern or northern border belts of the Ozark Dome, except that part of it lying close to St. Louis. Even here there has been no general development, the greater number of farmers preferring to confine themselves to grain farming. The German farmers of this region are not dairymen, although other conditions are favorable for considerable parts of the belt.

On the basis of the foregoing description of agricultural history and present stage of development reached in its different parts, the region readily falls into four subdivisions, as follows: (1) The lowlands of the Arkansas and White Rivers; (2) the Dome Border; (3) the Dome Center; (4) the Boston Mountain Plateau. Although the terms used in naming these subdivisions are geographical in character, they correspond, nevertheless, to agricultural areas as well.

THE LOWLANDS OF THE ARKANSAS AND WHITE RIVERS.

The first one in the list is the region where cotton growing is profitable. It includes the Ouachita Mountain belt, lying within the area,

and the White River Valley and adjacent moderately elevated land as high as the Missouri State line. A small amount of cotton is grown on the southern slope and at the extreme eastern end of the Boston Mountain Plateau. In the White River Valley region cotton is grown on the bottom lands. On the limestone uplands of Independence County it will produce a small yield, but is very little cultivated. On the sandstone soils of Izard and adjacent parts of surrounding counties, however, it is an important crop. It is on this soil that profitable cotton growing reaches its greatest elevation and highest latitude in the Ozark region. In the valleys of White River and its tributaries it extends across the State line into southern Missouri in a few places, but does not spread out onto the uplands. It extends into the valleys of the northern part of the Boston Mountain Plateau, but does not rise above the bottom land level.

On the alluvial lands of the White River basin corn and cotton are the principal crops, corn predominating except in the Oil Trough Bottom, a wide expansion of the White River alluvial lands below Batesville, where cotton growing is very profitable. During the last few years, however, alfalfa growing threatens to take the place of a considerable part of the cotton acreage on the best of the bottom lands, though it does not extend onto the uplands. It is not yet known that the upland soils will grow it profitably. The Izard soils are known to produce a sorghum from which a very high grade of sirup can be made.

In the Ouachita Mountain belt the lowland belts and the rather level uplands are cultivated; the ridges are usually timber covered. Cotton is the principal, almost the only, money crop grown. Corn is second in value to the cotton crop and is about the only crop other than cotton, except a small acreage of oats and hay. On the rather low-lying lands of the Appleton silty soils Japan clover produces a good yield of hay and is often cut for that purpose.

The western part of this belt and the adjacent south slope of the plateau, in the vicinity of Van Buren, has developed during the last few years into an important small fruit, melon, and potato growing section.

This part of the region is not one in which any considerable amount of unoccupied land still exists. It has been occupied many years and has adapted itself to the prevailing conditions of agriculture in the South. It is a region where negroes are numerous, although they are not the only farm laborers. A large part of the land is cultivated on the share basis. It is not a region for the newcomer seeking new and cheap land and pioneering conditions.

THE DOME BORDER.

The Dome Border includes the largest area of agricultural land in the region covered, except the lowlands of the White and Arkansas Rivers. As used in this discussion the term includes a belt of country varying in width extending in an unbroken belt around the eastern, northern, western, and southwestern sides of the Ozark Dome.

Throughout this belt agriculture long ago passed from the primitive stock-raising stage of development into the grain-growing stage. In parts of the region it has passed from this stage into the stage of special agriculture, such as dairying, and special crops, such as fruit growing. This is true of the broad expansion of the belt in southwestern Missouri and northwestern Arkansas. Its eastern and northern stretches are occupied almost exclusively by German farmers. It is here mainly a belt of corn, wheat, and hay growing. A region of well-cultivated farms, of well-built and well-cared-for farm houses, large brick or stone churches, and solidly built and neatly kept villages. Erosion of the grain-growing fields is a serious problem in a large part of this belt.

The rest of the belt is occupied by native American farmers who are engaged mainly in general farming, but who are diversifying this with fruit growing and in places with dairying.

THE DOME CENTER.

The Dome Center is characterized by less uniformity of conditions than the Dome Border or the lowlands. The alluvial lands are fertile and all in cultivation. The basins of Fredericktown soils of the east-central part of the area are all in cultivation. The upland of the Dent soils of Dent County and of the smoother areas of other soils are more or less occupied, but they are less fertile than those of the Dome Border and are much less carefully cultivated. General farming is practically the only kind of farming practiced, except where more or less stock raising, based on the grazing of the unoccupied Rough stony land, still lingers in a subordinate way. Along the two railway lines that traverse the area some attention has been given to special crops, but the only permanent success that seems to have been reached is the growing of peaches in the southeastern part of the area. Apple growing has for some time received considerable attention along the railways. Since 1890 there has been a marked decrease in the number of trees.

As a whole, the Dome Center is less developed than either of the other areas described, but better developed than the Boston Mountain Plateau. The latter is also less capable of development, contains a smaller proportion of agricultural land, and is less accessible. It is a region where stock raising and forestry are, under existing conditions, the only profitable industries possible.

THE BOSTON MOUNTAIN PLATEAU.

The boundaries of the Boston Mountain Plateau are shown on the sketch map (fig. 2). It is an area, taken as a whole, of soils of low fertility, rough topography, and inaccessibility. The only areas of agricultural land of any considerable size lie on the top of the plateau, where they can be reached from the outside only by a climb of about a thousand feet over roads that are practically impassible for vehicles with any considerable load. The only railway lines traversing it lie in deep valleys, there being only one point in the whole area where a transportation line can be reached without having to descend from the plateau.

The areas of agricultural land are small in size. Areas of more than a hundred acres of smooth land occurring in an unbroken body are of rare occurrence. The Boston Mountain plateau differs in this respect from large areas of the Allegheny plateau, where the slopes, although steep, are not too steep for cultivation over large areas. Many areas of land that were cultivated several years ago are now abandoned and new areas are not being cleared to take their place. The young people in the region leave it at the earliest opportunity, selling their land to the lumbermen.

DETAILED DESCRIPTION OF THE SUBREGIONS.

THE OZARK DOME.

LOCATION, AREA, AND GENERAL CHARACTERISTICS.

The Ozark Dome lies mainly in southern Missouri and northern Arkansas. Its boundary lines are shown on the accompanying sketch map (fig. 2) and need not be described in detail here. It includes an area of about 36,000 square miles.

It is a broad, low, elongated dome with its longer axis lying in a northeast-southwest position. Its southwestern end lies in the northeastern corner of Oklahoma and the northeastern end in Ste. Genevieve County, Mo. From Iron County, Mo., to Barry County, Mo., its crest line lies approximately level. Southwest of the latter point it slopes down to the prairies in Oklahoma, and northeast of the former it drops rapidly to the end at the Mississippi.

Northward and southward from this axis of maximum elevation the surface slopes to the prairies of northern and western Missouri, on the one hand and to the Mississippi Lowland and to the foot of the Boston Mountain Plateau front on the other. The elevation along the former line varies from about 600 feet in the vicinity of St. Louis to 850 feet at Lamar. Along the latter line the lowest point lies in the vicinity of Batesville, Ark., about 450 feet above sea level, and the highest point in the vicinity of Hindsville, Ark., where it lies about

1,300 feet above sea level. It is evident, therefore, that the boundary lines of the Dome lie higher on both sides of the axis near the western end than near the eastern. This is due to the fact that the bounding formations lie higher up on the slope of the Dome at this end than at the other. Toward the northwest, north, and northeast the Dome slopes gradually down to the lower country surrounding it and no noticeable topographic feature marks its boundary. Toward the east and southeast it slopes gradually to the top of the low bluff of the Mississippi Valley or the one that forms the boundary between the Dome and the Mississippi-White River Lowlands. Toward the south it slopes downward to the foot of the north front of the Boston Mountain Plateau. Its eastern, southeastern, and southern boundaries, therefore, are sharply defined and marked by distinct surface features. Its northern and northwestern boundaries, however, have no such topographic expression. A definite line must be sought in the geology. The Ozark Dome is a limestone region, while the surrounding country is made up of shales and sandstones. The western and northern Ozark boundary, therefore, is the boundary between the limestone country and the sandstone-shale country. It is the line along which the Ozark limestones dip beneath the overlying formations.

DRAINAGE.

The direction which the drainage of the greater part of the Ozark Dome takes is determined by the broad lines of its relief. The crest line of the Dome is a watershed. On the north side of the crest the streams flow northward, on the south side they flow southward. It is a rather striking fact, however, that although the Mississippi River flows across the eastern end of the Ozark Dome and the drainage of the whole region finally reaches that stream, only a very small part of the Ozark drainage flows directly into it. The northward-flowing streams reach it through the Missouri and the southward-flowing streams through the Arkansas. The local drainage is parallel to the master stream rather than toward it. There is, however, a narrow strip along the northern border where the dominant direction of the drainage is eastward rather than northward, where the influence of the local northward slope of the Ozark Dome gives way to that of the eastward slope from the Rocky Mountains. The streams subjected to this influence are the Osage, Bourbeuse, and the lower stretch of the Meramec.

There is no stream on the south slope of the Dome exactly comparable in position and course to the Osage on the north. The nearest approach to it is the Neosho, a tributary of the Arkansas, reaching that stream south of the west end of the Dome. The Arkansas and Missouri, on the other hand, are exactly comparable. The Gascon-

ade on the north is homologous to the White River on the south, while the small rivers draining the northwestern slope of the plateau into the Osage are homologous with the southeast group flowing directly down the slope of the Dome, this being in each case the steepest slope.

A striking feature of the drainage of the north slope is the unsymmetrical watersheds. Those between the Missouri and Moreau Creek, the Moreau and Osage, the Osage and Gasconade, the Missouri and Bourbeuse, and the Bourbeuse and Meramec are all unsymmetrical. In every case the watershed lies a long distance south of the stream on its northern side, but a short distance north of the stream on its southern side. The tributary streams flowing northward are long, while those flowing southward are short. The valleys on the north side of the watershed are shallow. The slopes are often comparatively gentle and the alluvial floors are comparatively wide, both on account of the shallowness of the valleys and the larger size of the streams. Those on the south side of the watershed are deep, narrow, and steep sided. The streams are short and therefore small and alluvial belts are much narrower. As the crest of the Dome is approached this lack of symmetry becomes more striking. It is more perfectly developed, for example, on the Osage-Gasconade and Bourbeuse-Meramec watersheds than on the Missouri-Moreau or Moreau-Osage. As a consequence of this lack of symmetry the south slopes of the watershed ridges are thoroughly and deeply cut to pieces by drainage, so that the land is too rough to cultivate, except in small patches. The population is scant. The north slopes, on the other hand, are gentle. There is often a considerable belt, just north of the crest, of smooth land, originally prairie land, in which the dissection is neither complete nor deep. Much of this portion of the upland is capable of cultivation. A considerable proportion, therefore, of the northward slopes is capable of utilization.

This lack of symmetry is not so striking on the south side of the Dome crest as it is on the north. It can be seen, however, on opposite sides of White River. On account of the strong relief in all this part of the region it has no practical bearing on the soils or their utilization.

RELIEF.

The physiography of the region, or the broad features of its relief, is the product of long-continued erosion, probably through more than one cycle, acting on a series of rocks varying in their powers of resistance to erosion and varying also in their attitude from essential horizontality to strong dips.

The detailed topography or the relief in detail, those features that are seen by everyone and which require no extended views, either

visual or mental, to enable anyone to be conscious of their existence, and those features that the average man sees and which determine to a considerable extent the agricultural value of the region, are the result of valley cutting by streams and usually during the existing cycle only. The roughness of the region or the strength of the local relief is a function of the number of valleys within a given region and the depth to which they have been cut.

The Ozark Dome is a region of strong relief in general when compared with that of the prairies of the surrounding country. It is now in what is known as a mature stage of topographic development. The dissection is, in a large part of the area, complete, and in many places it is deep. The whole region can not, however, be taken up and described in detail. The sketch map (fig. 3) shows the areas of country having less than 50 per cent and more than 50 per cent rough land, or land too rough to cultivate except in small patches. Even in areas where there is 50 per cent rough land a considerable part of it may be utilized for pasture.

It will be noticed that the areas of rough land run in belts following the streams. The region was once a smooth plateau. It would be smooth now, though not level, if it had not been cut to pieces in the neighborhood of the streams by the work of the streams and their tributaries. Where these have not yet reached or where, having reached, they, on account of the long distance, are unable to dig deep into the land, the country is smooth or relatively so. The Ozark Dome has a larger proportion of smooth land than the Boston Mountain Plateau, while the Ouachita Mountain belt has a larger proportion than either.

THE ROCKS.

The Ozark Dome is essentially a region of carbonate rocks. From the point of view of their agricultural value they may be considered limestones. They are all readily soluble and contain, when free from chert, sand, or clay beds, a small amount of soil-forming material. They will be spoken of in this report as limestones. They have not been sufficiently studied up to this time to enable one to describe or map the distribution of the pure or nearly pure lime carbonates and that of those containing high percentages of magnesia. A much more important characteristic agriculturally is their content of chert and of clay.

Some of the beds are pure carbonates or practically so, while others contain high percentages of argillaceous matter, as high in some cases as 50 per cent. Some of the beds are free from chert or other siliceous matter in considerable quantities, while other beds have been wholly replaced by silica in the form of chert.

While the same bed or series of beds does not remain absolutely constant in these respects over the whole area of the Ozark Dome,

change of character in any one bed, where it occurs at all, is very gradual. There are, however, a number of beds each possessing characters more or less distinct from those adjacent to it on either side. The processes of deposition and subsequent deformation and erosion have been such as to cause these several beds to occur at the surface, or immediately under the soil layer, in more or less continuous belts encircling the area of crystalline rocks in the eastern part of the Ozark Dome in a series of concentric rings. A subordinate center around which the rings are deflected lies in Camden and Laclede Counties, Mo. The encircling belts are not all of the same width, nor is any single belt uniform in width throughout its whole extent, nor are the boundary lines smooth. More often they are ragged. Their ringlike character of distribution is much better developed on the eastern side of the crystalline rock area than on the western.

The rocks of the Ozark Dome, leaving out of consideration for the present the unconsolidated deposits, consist of two of the main rock groups, igneous and sedimentary.

Igneous Rocks.

The igneous rocks lie in the eastern part of the area, occurring in small patches rather widely distributed. They are shown on all geological maps of the State, and on the soil map accompanying this report they underlie the areas mapped as Rough stony land. The rocks consist of granites and fine-grained eruptives, most of them acidic. The topography is rough, very few areas being smooth enough for cultivation.

The sedimentary rocks underlie the rest of the Dome area, and on the basis of lithologic character they consist of nine members, four of which are sandstones and five are limestones. In the order of their occurrence in the series of rings, beginning with the innermost, they occur as follows: (1) Sandstone, (2) limestone, (3) sandstone, (4) limestone, (5) sandstone, (6) limestone, (7) sandstone, (8) limestone, (9) limestone.

La Motte Sandstone.

The inner ring of sandstone forming the areas of Dent soils in St. Francois and adjoining counties is irregular in distribution. This is accounted for by the fact that it was not deposited as a continuous bed of uniform thickness. It is a sandstone made up chiefly of rather angular quartz grains with a considerable quantity of clay and some feldspathic grains. Locally it is very coarse and made up of well-rounded quartz fragments. It was deposited on the surface of the old crystalline rocks and made up of material derived from them. It varies in coarseness and character of grain, therefore, with the varying distance and character of the rock from which the

material was derived, whether it was granite or some of the more feldspathic and finer grained rocks. Under certain conditions therefore it is coarse-grained, practically pure white or gray quartzose sandstone, in other cases it is a very argillaceous, fine-grained sandstone, and in still other places a feldspathic rock. It is gray to brown in color.

It occurs only in close association with the ancient crystalline rocks, either in irregular patches within their area, when it covers them, or in small patches around them. It is known in Missouri geology as the La Motte sandstone and is very old, having about the same stratigraphic relations as the Potsdam sandstone.

PROCTOR-ST. JOSEPH LIMESTONE AND DAVIS SHALE.

This series of rocks, which forms the Fredericktown soils, occurs mainly in the eastern Dome, with a small area in Camden County. While the rocks may not be of exactly the same geological age in all the separated areas they occupy the same relation to overlying formations in all and are much alike in character. They have one character, very important in its effect upon the soils of these areas, that is common to all areas—the rocks are practically chert-free. The Camden County area is made up of coarsely crystalline gray limestones or dolomites.

The area of the eastern Dome contains two kinds of rocks. The lower beds are very much like those in the Camden County area. Above this lies a series of thin-bedded, fine-grained, and somewhat earthy rocks, including one important bed of shale and some coarsely crystalline beds. The shales and fine-grained beds constitute the greater part of the upper series, while the lower series is mainly crystalline in both areas. The shale and fine-grained beds of the eastern area are not present in the western. The rocks in the smaller eastern areas, such as the one in Wayne County, Mo., and some of the small ones in Washington and other counties in the same State, are more like the crystalline beds than the higher, more argillaceous series.

GASCONADE-ST. ELIZABETH LIMESTONE.

The Gasconade-St. Elizabeth series of rocks, which underlies the area of Clarksville stony loam, is one of the most important in the whole Ozark Dome region. It is relatively thick and has a wide distribution. It completely encircles the central crystalline area, though that part of the ring lying on the western side of the crystallines opens out into a broad area with many subordinate areas. It encircles also the Camden County subcenter, forming here an area of country exactly like the main area.

Although this series of beds is widely distributed over the region its characters are very persistent. They present the same petro-

graphic characters in southeastern Missouri as in the most distant part of the Camden County area. The different members of the series differ, however, considerably. The limestone members differ in coarseness of grain, purity, or proportion of pure carbonate and in the quantity of chert that they contain. The lower member of the series consists of a coarsely crystalline limestone not differing in this respect from the underlying Proctor-St. Joseph-Fredericktown limestone. It contains, however, especially in the main area, a considerable amount of chert in the form of thin slabs, studded on one side with druses of quartz, the other side being extremely uneven in detail, owing to its having formed on an uneven surface of limestone. This chert is due to cavity filling by deposition from siliceous solutions, while most of the Ozark chert is due to replacement of the limestone, molecule by molecule, by the silica. The former is pure silica, except the small amount of coloring matter it contains and more or less argillaceous matter. The latter may be the result of complete replacement, in which case it is like the drusy chert in chemical composition, or it may be, and usually is, the product of partial replacement. In the latter case it will contain more or less lime in its composition. This member of the series is found only in the main area. It is not known to occur in the Camden County area. Upward the percentage of ordinary cryptocrystalline replacement chert increases, and that with drusy surface decreases in quantity. The limestone, however, remains about the same in character, possibly becoming more finely crystalline. The proportion of chert to limestone increases, however.

This may be considered the lower cherty member of the series, while the drusy chert member may be considered as a transition member from the noncherty Proctor to the lower cherty members of the Gasconade. The chert of this member is not uniformly distributed through the formation, but occurs chiefly in the bedded, very much jointed, rather finely crystalline limestone which alternates with more massive, coarsely crystalline and chert-free beds. This character affects the soil produced from this member to a considerable extent. The massive crystalline beds disintegrate into silty clays of deep red color which form a rather fertile and good water-holding subsoil for the cherty soils, usually gray to brown in color, derived from the more cherty layers. This member of the series is about 150 feet thick, but on account of its horizontal lie it has a wide distribution.

Above it lies a series of massive coarsely crystalline chert-free beds of about the same thickness as those in the lower member. They decompose into a brown to red chert-free silt to silty clay soil, naturally fertile, but on account of the position of its outcrop its unmodi-

fied soil is found in small areas only. It occurs in most places on hillsides only, where it is overlain by the next higher member of the series. Its soil is usually covered with chert that has crept down the slope from this overlying formation.

Above it lies a very cherty formation varying in thickness from 30 to 100 feet or more. It contains chert not only in nodules and druses in the limestone beds, but massive beds of brecciated chert up to 2 feet or more in thickness. This is the most cherty formation in the whole series of Ozarkian limestones. Owing to its wide distribution and the indestructible character of the chert it is the strongest and most important member of the series in its influence on the soil of the whole area.

ROUBIDOUX SANDSTONE.

The Roubidoux sandstone which forms the Dent soils in Dent and adjacent counties has a wide distribution in the Ozark Dome region, but except in its main area in Dent County is not thick enough to be a dominant factor in soil formation. It outcrops usually on slopes. The more persistent cherts from the overlying limestones creep down over it from above, concealing it and its influence. Its maximum thickness is nearly 200 feet. This occurs in the central part of the Missouri Ozark region. Outward from this region it soon thins to a very few feet. As a bed of sandstone, however, it has a wide extent.

JEFFERSON CITY LIMESTONE.

The Jefferson City limestone is another formation that forms an unbroken belt around the center of the Ozark region. Like all the others, however, the width of the belt is not uniform. It is broader in the western and southern part of the region than in the eastern and northern. Like all the other limestones of the region, also, its character as a whole is persistent over a broad area, though it varies more than does the Gasconade. The Union, Berryville, and Howell soils are derived from this formation.

Like the Gasconade formation, it consists of a series of beds differing somewhat from each other in petrographic character. The lower member is a fine-grained, moderately crystalline gray and blue limestone with thinner layers of shale and thin layers of soft earthy limestone or "cotton rock," carrying more or less chert locally, but only in very rare cases enough to interfere with the cultivation of the soil derived from it. It has not been studied in sufficient detail to determine whether it is coextensive with other members of the formation. It occurs as an important soil former in the southeastern Ozark region of both Missouri and Arkansas and in the drainage basins of the Osage and Gasconade Rivers. If it occurs along the eastern part of the ring formed by the formation it is very narrow and inconspicuous.

Above this lies a formation that differs from the basal one chiefly in the proportion of chert that it contains. The limestone of this member is very much like that of the lower one, but the much higher percentage of chert differentiates the two very sharply. The region where this member occurs typically lies in the southeastern Ozark region of Missouri and adjacent portions of Arkansas, with Howell County, Mo., in the central part of it. It extends down the eastern side of the region in a narrow belt to the lowlands in Bollinger and Cape Girardeau Counties in Missouri. It is not so cherty in this belt, however, as it is in the main area. In the Gasconade and Osage basins it occurs over a large area. Its chert content varies somewhat, but it is never chert free and rarely cherty enough to prevent the utilization of the soil derived from it. As a rule it is somewhat less cherty than in the typical area of Howell County. The limestone also seems to be more earthy, a smaller proportion of crystalline limestone and a larger one of "cotton rock."

The upper member of this group consists of a series of beds carrying a small amount of chert, much of it being entirely chert free. The rock consists of finely crystalline gray limestone, white earthy limestones, locally known as "cotton rock," thin-bedded gray earthy limestone, shaly limestone, and yellowish, grayish to greenish shale. Chert occurs in beds usually less than a foot in thickness and in concentric nodules distributed through the limestone. The chert beds break up into rough, angular, but often rather large blocks, while the nodules occur in the soil very much as they occur in the rock.

On account of the small amount of chert contained in this group of rocks, masses of chert fragments do not accumulate on the surface, except locally, to hold the finer material of the soil in place, so that it is washed off of steep slopes as rapidly as formed. This, with the lower member of the group, therefore, is the rock chiefly responsible for the "glades" or bare slopes of ledge rock kept washed free from the soil that are such conspicuous features in the White river basin.

Crystal City-Melbourne Sandstone.

The Crystal City and Melbourne sandstones occur in widely separated portions of the Ozark region. The Tilsit soils are derived from the former and the Izard from the latter. They lie apparently on the same horizon, or if this is not the case they can not be far apart in age. They are very much alike in physical character where both are pure, but on account of their occurrence in widely separated areas and the fact that the Izard sandstone is not often pure, they will be described separately. The Crystal City sandstone is coarse-grained, gray to white, and made up of extremely well-rounded transparent quartz grains, held together very loosely by a small amount of calcareous cement. There are occasional streaks of iron oxide cement,

but it occurs so rarely that its effect on the soil is wholly negligible. It outcrops in a rather narrow belt running from Callaway County, Mo., eastward and southeastward through Montgomery, Warren, St. Charles, Franklin, St. Louis, Jefferson, Ste. Genevieve, Perry, and Cape Girardeau Counties in Missouri. It does not occur in Arkansas. The belt of outcrop varies in width from nothing up to 6 or 8 miles. The formation is usually somewhat more than 100 feet thick.

The Melbourne sandstone consists of an upper and a lower bench of sandstone and an intervening member of chert-free limestones which are usually quite sandy. The two sandstone benches are each about 35 to 40 feet thick where well developed and are much alike in composition. Both beds are made up of rounded grains of quartz, large enough to make a coarse sandstone. They are rather loosely held together by a calcareous cement. The stone, therefore, is usually gray or white in color. The lower bench does not seem to be so persistent as the upper. The latter occurs in a belt extending from the lowland boundary in Lawrence County, Ark., westward through Independence, Sharp, Fulton, Izard, Baxter, Stone, and Marion Counties. In the western part of Marion County it has become so thin that it has very little effect upon the soils. It does not occur in Missouri along the main line of its outcrop belt, but is thought to be represented in the Spring Creek Hills of Ozark County, Mo., by a rather thin sandstone occurring there. It does not, however, have a wide distribution here, because only a small area of country lies high enough to intercept its horizon. The upper bench occurs well developed only in Stone and Izard Counties. Eastward and westward it thins and is displaced by limestone. It is so much like that of the lower bench in petrographic character that it does not need any further description.

The middle member of the group in the main area of its distribution is a sandy limestone. The percentage of sand varies from nothing up to 90 per cent. It is distributed through the rock and also occurs in thin layers and lenses of nearly pure sandstone. The less sandy portion of the rock is a rather massive blue to gray, coarse to medium grained, hard crystalline limestone. The weathered surface of the more massive beds has a dark-bluish shade. In both directions from the main area of its occurrence in Izard and Stone Counties, Ark., its sand content decreases and it gradually becomes a limestone. It is not known to occur in Missouri. An area of sandstone of small size and subordinate influence as a soil former occurs in Webster, Polk, and Dallas Counties. It is probably the same as the Melbourne.

Izard and St. Clair Limestones, the Marble Beds of the Lower Carboniferous, and the Hannibal and Eureka Shales.

These formations outcrop in a very narrow discontinuous belt lying along the boundary between the Springfield soils and the Howell soils in western Missouri and northern Arkansas. They are chert-free shales and limestones, but do not occur in a belt wide enough to form a distinctive soil belt. In small areas, too small to show on a reconnoissance map, they form Hagerstown soils in Independence County, Ark., and Hannibal soils in a few places in Webster, Polk, Dallas, and Hickory Counties, in Missouri. Some of the areas of Howell soils in this latter region are more or less influenced by material from the shales in this group of rocks.

Lower Carboniferous Limestones and Cherts other than those Already Described.

The lower Carboniferous formations give rise to the Springfield soils. The rocks consist of crystalline limestones, varying from fine to coarse, all containing more or less chert, but varying in the quantity from place to place. There are several limestone beds in the lower Carboniferous group and the Burlington crinoidal limestone is practically the only one of importance as a soil maker. Some of the others occur in a few places, but they are thin and their soils are lost in those of the more dominant Burlington.

The limestone part of the formation is mainly a very pure, coarse-grained, highly fossiliferous lime carbonate. The chert occurs in discontinuous beds and nodules, in some cases making up the greater part of the rock. It is cryptocrystalline, rarely chalcedonic, and often contains a high percentage of lime.

The latter upon weathering changes to a soft, porous, amorphous mass usually known as "red flint"; that with a smaller proportion of lime changes very little on weathering, is whitish to bluish in color, hard, dense, and angular, and is called "white flint." Occasionally the chert occurs in massive beds several feet thick, but they are not persistent along the horizon in which they occur. They soon give place to the normal limestone and chert.

The main area of occurrence of this formation is in southwestern Missouri and northwestern Arkansas. It extends also into northwestern Oklahoma. From this area a narrow belt runs southeastward along White River to the lowlands in Independence County, Ark., and another one starting out northward encircles or forms a border around the western, northern, and northeastern parts of the Ozark region. In a few places along the northeastern part of the region the Burlington limestone border lies across the Mississippi River in Illinois. At one time it formed a continuous border entirely around the region, but a long stretch of it in the head of the Mississippi

embayment, including a large area of the region well within the Dome border, has been cut off by the Mississippi River and its stump buried by the alluvial deposits of that stream as well as by the overlap of the Coastal Plain deposits.*

*In discussing the soils of the Ozark region the subject has been treated not for the region as a whole, but for different sections of the region, each with its peculiar conditions. The soil types have been shown by means of colors in the accompanying map and the areas of the different types or type groups have been determined approximately by means of planimeter measurements. In the table below these measurements have been tabulated and the relative extent of each type or type group worked out on a percentage basis.

Areas of different soils.

Soil.	Acres	Per cent.	Soil.	Acres.	Per cent.
Howell soils [1]	5,842,944	18.1	Appleton silty soils	628,992	1.9
Springfield soils	4,893,696	15.2	Owensville silt loam	550,656	1.7
Clarksville soils [2]	4,550,400	14.1	Jamestown soils	541,440	1.7
Alluvial soils [3]	3,785,472	11.7	Fredericktown soils [5]	435,456	1.4
Fayetteville soils:			Dent soils	343,296	1.1
Stony loam	1,951,488		Appleton soils [6]	299,520	.9
Mainly silt loams	589,824	10.1	Cedar Valley soils	294,912	.9
Lowland phase	714,240		Hanceville soils	274,176	.9
Lebanon soils	1,428,480	4.4	Rough stony land [7]	241,920	.7
Union soils	1,331,712	4.1	Tilsit soils	177,408	.6
Hagerstown soils [4]	979,200	3.0	Winslow soils	129,024	.4
Izard soils	776,448	2.4	Glenn soils	69,120	.2
Berryville soils	755,712	2.3	Pocahontas soils	27,648	.1
Iberia soils	665,856	2.1	Total	32,279,040	.....

[1] Includes some Clarksville.
[2] Mainly stony loams.
[3] Mainly Huntington.
[4] Includes small areas of Colbert and Decatur.
[5] Includes Decatur, Hagerstown, and Colbert.
[6] Includes ridges of Fayetteville and Cedar Valley soils.
[7] Includes soils derived from igneous rocks.

NOTE.—In 1908 the Missouri Experiment Station issued a report on The Soils of the Ozark Region, Research Bulletin No. 3. This report covers the same region and in addition a considerable area in Arkansas. The areas and soil names do not agree on the two maps, partly because of increased knowledge of the area and partly because of the attempt to use names where possible that are well established in the bureau's nomenclature. The St. Francois group of soils on the Missouri map is the same as the rough, stony land of this report.

The relations of the soils are shown in the following table:

Bureau report.	*Missouri report.*
Rough, stony land.	St. Francois group.
Dent soils (Ste. Genevieve area).	Lamotte group.
Fredericktown soils.	Caledonia group.
Clarksville soils.	Reynolds group.
Dent soils (Salem area).	Salem group.
Iberia soils mainly; partly, also, Lebanon, Clarksville, and Howell.	Vienna group.
Howell soils mainly; partly, also, Berryville.	Lebanon group.
Howell soils.	Howell group.
Union soils mainly; Hagerstown also.	Union group.
Tilsit soils mainly.	Hillsboro group.
Hagerstown soils.	Perryville group.
Springfield soils and Hagerstown soils and Pocahontas soils.	Wittenberg group.
Owensville silt loam and Lebanon soils.	Owensville group.
Owensville soils mainly.	Osage group.
Lebanon and Howell soils.	Bolivar group.
Springfield soils.	Springfield group.
Not mapped.	Barton group.

SOILS IN GENERAL.

The Ozark Dome is a large area and includes a wide range of conditions that are of determining influence in soil building and in agricultural progress. Its several parts vary widely in the character of the rock underlying the country, in the topography, and to a considerable extent in climate. These factors have caused still wider variations in the character of the soils which have been produced by them, and since economic conditions are dependent on the combined effect of all these factors such conditions must vary more widely than any one of the natural factors, no two of the latter neutralizing each other.

The soils are alike in being practically all residual, leaving out of consideration for the moment the alluvial soils, most of which are merely reworked local material. They are alike also in being almost universally of a grayish, yellowish, reddish, or brownish color—some color other than black. They differ also from the surrounding prairie soils in being almost universally stony.

In the Ozark Dome the soils, including the silty phase of the Fayetteville, have been differentiated into 16 groups, each being derived from rocks differing from those of each of the other groups in lithologic character.

The area including the soils of each group, with one or two minor exceptions, occurs as a belt of varying width and curving more or less parallel with the boundaries of the region. The whole region becomes, therefore, one of concentrically arranged belts of soils, few of them making a complete circuit, but all of them curving with the curve of the regional boundary. In some cases the distribution is obscure because of the raggedness of the boundary lines due to dissection and because also of the varying width of some of the belts. The area of Rough stony land soils is the center around which the other soils are grouped.

In one or two cases the same soils occur in more than one of the concentric belts, the two belts being entirely separated from each other by intervening soils of different character. This is one method of expressing the fact that it is the character of the rock that determines the character of the soil rather than the age of the rock. Where the same soils occur in two or more districts it is due either to the reappearance of the same formation or to the appearance of an entirely different one with the same lithologic characters.

Leaving out of consideration, for the present, minor features, the soils of the Ozark region belong to three great soil groups or provinces. Two of these groups are restricted, in the main, to definite and separate areas, so that these soils are grouped not only according to relationships, but this same grouping expresses in part at least the physiographic areas of the region. The distribution of the soil

groups, therefore, expresses the physiographic grouping of the country as well.

The region includes an area of soil belonging in the Limestone Valleys and Uplands province, and another in the Appalachian Mountains and Plateaus province. In addition to these a third province, not physiographic or geographic in its characteristics, occurs in the region. This is the Alluvial province.

SOIL GROUPS.

Rough Stony Land.

Distribution.—Considerable areas of Rough stony land occur in the Ozark region, but they have not been differentiated from the soils with which they are associated except in the area of St. Francis Mountains, where practically all the area of this material is non-agricultural. All the areas of this kind of country lie in the eastern Ozark region, mainly in Iron, Madison, and St. Francois Counties.

Topography.—Topographically the area consists of a series of low conical hills, locally called mountains, rising to a maximum height of about 700 feet above the adjacent lower country, standing in groups or as isolated individuals on a plain, underlain in part by the same series of rock that forms the hills and in part by the rocks from which the soils of the second province were derived. That part of the province involved in the formation of the plain on which the peaks stand is not too rough for cultivation, but owing to the character of the soil and the abundance of stones in it very little of it is cultivated. As a whole the soil must be considered practically non-agricultural. The valleys within the province are mere gorges, none of them having alluvial belts wide enough for even small farms. The soils therefore are all upland soils.

The rocks.—The rocks underlying the area are igneous rocks, consisting of granites, rhyolites, trachytes, and diabases. The most abundant rock is a dense hard porphyritic trachyte. The granite underlies the smoother area, while the peaks are made up of the denser more resistant "porphyry."

The whole area, except the few small patches that are cultivated, is covered with a growth of oak, black oak chiefly, with scattered white oak and red oak. Post oak occurs with the others on the smooth areas underlain by granite.

The soils.—The soils are gray, usually very stony silts and silty clays, with brown or yellow subsoils, the latter being full of stones also. They are all shallow except where locally accumulated. The granite soils are more argillaceous, especially in the subsoil, and the soil usually is lighter in color than the "porphyry" soils.

The siltiness of the soil on the smoother areas is probably due to the fact that some of the silt from limestone formerly overlying the granite has been left on it and mixed with the disintegrated products of the granite.

Dent Soils.

Distribution.—There are two main areas in which the Dent soils occur, with a number of small areas associated with each. One area lies in the eastern Ozark, mainly in Ste. Genevieve County, Mo., the other in Dent County, Mo. The former area is designated as the Ste. Genevieve, the latter as the Salem area. They are both derived from sandstones, not, however, of the same age, though they are essentially alike in general character and composition.

Topography.—In the Ste. Genevieve area these soils occur in a smooth to moderately hilly country, the elevation of which ranges from 800 to 1,000 feet. In the Salem area, on the other hand, the elevation ranges from 1,000 to 1,400 feet. The local relief, however, is not essentially different from that of the Ste. Genevieve area. The area lies on and near the main watershed of the Dome. The streams are all small, the valleys shallow, and the slopes rarely steep. So far as topography is concerned very little of the area is too rough to cultivate. The soils in both areas are gray to brownish in color, the subsoils varying from yellowish to brownish, with red appearing in the deep subsoil. The greater part of the soil is a loam rather than a sandy loam. Sands do not occur in any considerable area, and a considerable part of the soil is silty. The subsoil is usually heavier than the soil.

The Ste. Genevieve area.

A relatively small part of this area has been cleared. Most of it is still covered with scrub-oak brush. It is not wholly infertile, but it is so much less fertile than the adjacent areas of limestone soils that it has not offered much inducement to the farmer. It lies also in a region where very little increase in the agricultural population has taken place during the last 30 or 40 years. In the last 20 years there has been some slight decrease, owing to the development of the southeastern lead mining industry.

No attempt has been made to farm this land, when it is farmed at all, in any way different from the system practiced on the heavier limestone land in the same region. It is not light enough for a good truck soil, and it can not compete successfully with truck grown on the more fertile limestone soils of adjacent areas. It is too far from market also for the development of an extensive truck growing industry. The local market is good as far as it goes, but it is not large enough to absorb the product from the whole area in which the soil occurs. The soil washes rather badly, a combined result of

rolling topography, very low humus content, an open soil, and a rather heavy subsoil.

Owing to the character of the soil and the location of the area it must continue to grow general farm crops. In order to do this profitably it must be manured with barnyard and green manures. Commercial fertilizers alone will not redeem it, because its main deficiency is in humus and these do not add humus to the soil.

THE SALEM AREA.

The main part of the Salem area lies in Dent and adjoining counties in Missouri. There are some narrow belts and patches of the same soil that extend outward from this, as well as isolated occurrences found in many parts of the region. Some of these have been located, but no claim is made that all have been found and located on the map.

The main area lies on and near the main watershed of the Ozark Dome and in a locality where the country for a considerable distance north of it is rolling to only moderately hilly. The streams flowing northward from the watershed into the Meramec River have shallow valleys, even as far as 10 to 15 miles down stream from their sources, many of them having valleys with bluffs barely 50 feet high. They often start off from the watershed as broad sags rather than as deep ravines. Their distance to the sea by the roundabout way they take is so great that they are not able to cut their headwater ravines deep into the country.

The topography of the narrow belts and small areas occurring irregularly over the adjacent region is usually somewhat rougher than that of the main area.

The Dent soil is derived from a medium to coarse-grained brown, to reddish-brown to gray sandstone, consisting mainly of imperfectly rounded quartz grains with small amounts of chert grains. It is underlain by limestone with a great deal of chert—the Gasconade limestone—and in a part of its area it is separated into two beds by an interbedded limestone. Shale layers rarely if ever occur.

On the dry, undulating to rolling sandy land blackjack oak is the most common tree. Where the surface is smoother and the soil has a higher percentage of clay, is gray in soil and pale yellow or gray in subsoil, postoak is the most common. The two trees occur together over most of the area, though usually one or the other predominates. Where the soil is sandy on the surface but the subsoil is made up of cherty clay or silt, especially if it has a reddish color, black oak is the predominant tree. Such places occur around the borders of the area, where a large part of the subsoil comes from limestones belonging either above or below the sandstone.

A considerable area of this soil, although it is in a rather smooth region, is still in timber or brush. Cultivation is confined prin-

cipally to the valleys and valley slopes. The ridges are rarely cleared. The valleys are usually merely sags and have colluvial rather than alluvial soils.

There has been no attempt to adapt the crop to the soil, except a rather spasmodic attempt several years ago to grow fruit. The enthusiasm in most of the cases lasted only through the planting period, so that the trees were never well cared for, with the usual result in such cases. The climatic conditions, however, make exclusive fruit growing a very uncertain system of farming.

On account of the iron mining and smelting industry, along with its associated charcoal industry, which flourished from about 1875 to 1886, agriculture was very much neglected. It has not even yet reached a stage in development equal to that attained in regions whose soils are essentially the same, on account of the inherited mining attitude rather than an agricultural attitude of the people. Mining in the region is now a matter of the past, so that attention is being more and more turned to farming. The soil is too heavy for a trucking soil of the first class and the region is too far from market for this line of farming. The climate is not favorable to tree fruits as an exclusive farming system. It can not become a prosperous grain-farming region on account of the moderate fertility of the soil and its rapid deterioration under exclusive grain culture. A combination of grain, grass, and live stock is the only combination that suits existing natural and artificial conditions in the region. The soil will grow the bunch grasses, and with liming it will grow clovers. It will even grow them in a fair way now. Liming is a simple matter on account of an abundance of limestone on all sides of the area. Much of it is magnesian limestone, but pure limestone or limestone sufficiently pure for agricultural purposes can be got within hauling distance of practically every farm. At the present time, however, humus is more needed than lime; both are needed to make the soil productive. The humus requirement will be more difficult to supply than the other. If put on in the form of barnyard manure or legume crops turned under, so much the better.

There is a great deal of land in the area that can be cultivated that is still in timber or brush. Very little land has been cleared during the last decade. Probably more has been abandoned than has been cleared during this time. This is one of the areas of the Ozark region in which abandoned land is to be found. It has not been abandoned on account of its being worn out; its original small supply of humus has been burned out; otherwise it is the same as it ever was. The whole region could be made much more prosperous through the intelligent production and application of humus to the land.

FREDERICKTOWN SOILS.

Distribution.—The soils of the Fredericktown group are of restricted distribution, occurring in the eastern part of the Ozark Dome only, with the exception of a small area in Camden County, Mo. The main area lies in St. Francois and Washington Counties, Mo., with smaller areas in adjoining counties.

The Fredericktown soils range from gray to red in color. The subsoils range from yellowish to red, rarely grayish. In texture, however, they are much more uniform. They are all fine-grained soils, all of them very silty, ranging from silt loams to silty clay loams. They are all stone free or essentially so.

The layer of soil material is thick enough to satisfy the requirements of good soils in this respect. The underlying rock is not frequently exposed on the smoother areas and it is rarely struck with the 36-inch auger.

The main area occurs in a belt lying in a northwest-southeast position. A number of small areas occur scattered over the region surrounding the main area.

There are at least three series of soils occurring in this area. Two of them are among the most fertile limestone soils in the United States. The deep-red soils with deep-red subsoils are members of the Decatur series, the silt loam and the silty clay loam being probably the only types represented. The brown soils with brown, yellowish-brown, and reddish-brown subsoils are members of the Hagerstown series, the same type occurring as in the Decatur series. Both these series of soils are well drained and productive. The gray soils with grayish to yellowish subsoils are much less productive than the other two series. Their lack of productivity is due to the lack of good drainage as a rule. When well drained they produce good crops of grain and in their natural state they are good grass soils. These soils are members of the Colbert series.

The rocks.—These soils are residual, in this case demonstrably derived from rock of the same character as the underlying rock. If any considerable amount of soil material had been left here by originally higher formations it would be readily evident on account of the very different character of the overlying rocks. The latter are extremely cherty and would undoubtedly have left more or less chert in this soil.

The rocks from which these soils have been derived consist of gray medium coarse to coarsely crystalline, usually chert-free limestones and magnesian limestones, alternating with less crystalline, more argillaceous, and more thinly bedded rocks, passing in a few localities into shales. The latter occur in only one locality to any extent,

[1] Includes Decatur, Hagerstown, and Colbert.

though bedded limestones in beds of ordinary thickness make up the main body of the series.

The massive beds are often exposed at the surface with very little soil covering, weathering usually into extremely rough surfaces by the rapid weathering out of softer spots, leaving small pits all over the surface and small holes penetrating the rock in all directions.

The more thinly bedded rock is often exposed over considerable areas of sloping surface with only enough soil to permit the growth of cedars, they supporting themselves not in a soil but in the crevices of the rock. Such areas are called "glades."

The massive beds occur in some areas to the exclusion of other beds, while other areas are composed mainly of the thinner bedded rock. The Camden County area is made up mainly of the more massive crystalline beds. The shale beds occur abundantly only in the neighborhood of Bonne Terre, in St. Francois County, while the thin-bedded layers occur well scattered in most of the areas.

Topography.—All the occurrences of these soils occupy lowland basins. The soils of all the neighboring series, with the exception of the small area of Dent soils, occur in areas that are both higher and rougher than the areas of Decatur soils. They contrast sharply with the other soil types in this respect. The surfaces of the basins is best described as undulating to rolling.

A considerable part of the areas is smooth enough to cultivate easily, approaching in topography more nearly to that of the great limestone valley of Pennsylvania and Virginia and the smoother part of the Bluegrass Region of Kentucky than does any other area or series of areas in the Ozark region. Along the larger streams valley cutting has gone on at a considerably more rapid pace than general degradation of the upland, resulting in the formation of a hilly belt varying in width with the size of the stream and the elevation of the upland above grade level.

In these areas the soil is thin and bedrock is abundantly exposed, forming large areas of "glades."

The elevation of the basin floors above sea level varies from about 500 feet in Wayne County to 1,200 feet in parts of Iron and Washington Counties.

Native trees.—The character of the native timber differentiates itself according to the character and depth of the soil. On the Hagerstown soils walnut, elm, red oak, white oak, ash, hackberry, and wild cherry occur abundantly, except where the land has been cleared. On the shallow soils and the "glades" the trees are chinquapin oak, ash, red oak, and cedar, the latter constituting the principal tree growth on the "glades." Along with these grow abundant black haw and buckeye shrubs. The Hagerstown and Decatur soils are derived mainly from the more crystalline of the

rocks, and, what is probably more important than this, occur within the rolling to undulating areas. The Colbert soils occur on the flatter areas and in some cases, at least, are derived from the more shaly beds of the series. The difference seems to be, to a considerable extent, one of drainage. They occur most abundantly near the borders of the basins, where they lie adjacent to the Clarksville soils. A considerable area lies along the western side of the Richwoods Basin in the vicinity of Bismark, west of Belgrade, covering a considerable part of the Belleview and Iron Mountain Basins and the northern and western parts of the Patterson Basin. They occur, in fact, wherever the drainage is poor.

Within the Ozark region there are about 500 square miles included within the areas of these basins.

Crops.—These soils are grain and clover soils. They produce good crops of wheat, corn, and clover, but the yield varies with the soil type. The brown, well-drained soils yield best, while considerable areas of the gray soils are not cultivated at all, being used as pasture land. These areas, however, occur mainly where the soil layer is thin and the land soggy in wet weather and dry and cracked open in dry weather.

On the gray lands pasture, meadow, and small grains are the more common crops, while wheat, corn, and clover are grown on the brown soils. The yield of wheat varies from 6 to 25 bushels, the variation being due in many cases to lack of care or mistreatment of the soil, or to unfavorable climatic conditions. The average grade of brown land, well treated, manured, and carefully cultivated will produce 20 to 30 bushels of wheat, 40 to 60 bushels of corn, and a ton and a half of clover to the acre. At the present time about half to three-fifths of these yields are being obtained. This must not be charged up to the land, however. Under a well-organized crop rotation and a system of live-stock farming, with the careful use of all the manure produced, this land will grow good crops for a long period of time without the application of fertilizers. The main thing needed now is humus. On account of the lack of it fertilizers, especially on wheat, give increased yield, but the increased yield would be obtained without them if the soils were properly cared for. The gray soils are much less fertile than the brown. They are cold and intractible, too wet or too dry. They are usually somewhat more stony than the brown soils, the stones from the Clarksville series drifting down over them more or less. The yields, therefore, are considerably lower than those of the brown soils. It is not a good grain or clover soil, though it will grow both. Where there is merely a thin layer of soil with the solid limestone rock less than 6 inches beneath the surface, it will never be an important crop producer. Where, on the other hand, it is merely in need of drainage, aeration, and humus, it can

be redeemed by correcting these defects. It is more often in need of humus than of artificial drainage. There is no better way to supply the vegetable matter than by growing clover or cowpeas and turning them under or by feeding them and spreading the manure on the land. The redemption of such soils, however, can not be effected in one year, nor in two. It is the work of several years of careful, thoughtful, persistent treatment.

The brown soils grow vegetables of excellent quality, but they are not light enough to grow them for distant markets or even for the St. Louis market, since the soil near the city is just as good for vegetables as this. There is, however, considerable local demand for truck by the mining population. This is of importance in the vicinity of the mining towns Bonne Terre, Flat River, Elvins, Doe Run, Mine Lamotte, and Fredericktown, but the demand is not sufficient to cause an extensive development of truck growing over the whole area, which will remain, as a whole, a general farming region or develop the dairying industry. There is an abundant opportunity to do this. The market for milk and butter is not so dependent upon cheap transportation as is that for truck. All of the Decatur soils will grow good grass and clovers. The pasture problem is a simple one, therefore. There is enough grain grown to supply the concentrates, but not enough to make steer feeding profitable. The main things lacking for the development of a prosperous dairy industry are cows and dairymen. The destiny of the region for several years to come is to remain a general farming section.

White men began the permanent occupation of these basins nearly 200 years ago. At first they were mining adventurers, but more or less crop growing and stock raising were engaged in from the beginning. These were occupied earlier than any other portions of the State, except the alluvial lands of the Mississippi River. Mining began in 1720, and a large part of the land of the basins was taken up before the close of the century. The claims do not seem to have been confirmed by the Government to any great extent until about the latter part of the last decade of the century, after Americans had come into the region. The large mining grants were confirmed by the Spanish Government soon after mining began. Long after agriculture was well established in these basins and the towns had grown to considerable frontier villages the surrounding areas were occupied by Indians. As late as 1820, a hundred years after the French began to settle permanently in these limestone basins, the rest of the Ozark Dome country was wholly unoccupied except by a few hunters. The early occupancy of the whole basin area is proved by the fact that it is covered by old surveys that were laid out before the Land Office survey of the region was begun. They do not occur in any other portion of the Ozark region, yet the Land Office survey was begun in

1820. Practically all of the basin land was occupied by grants before that date.

Hagerstown Soils.[1]

Distribution.—Within the Ozark region there are two important belts or areas of typical Hagerstown soils and several small areas that vary slightly from the type but not far enough to warrant their separation at present. All these areas are in the eastern part of the region, one of them making a part of the northeastern border from Cape Girardeau County, Mo., to Jefferson County, Mo. The other area lies in Ripley County, Mo., and Randolph, Fulton, Izard, Sharp, Lawrence, and Independence Counties, Ark.

The soils are brown, occasionally gray, usually stone-free silt and clay loams, occasionally becoming very fine sandy loam.

The Perryville area.

The Perryville area is the main body of the Hagerstown soils. It occupies a belt of varying width extending from the southeast Missouri Lowlands northward through Cape Girardeau, Perry, Ste. Genevieve, and into Jefferson County. The Trenton limestone from which the soil of the belt is derived continues through Jefferson and St. Louis Counties, but as a very narrow belt. The areas of soil derived from it are small and were not mapped, though small areas are known to occur.

Topography.—Throughout Cape Girardeau and Perry Counties the belt is broad and the topography undulating to rolling, except along the creeks, where it is hilly. A large part of it is cultivated and has been cultivated for nearly a century. The smoother parts of it are covered by Spanish land grants, most of which were granted to Americans during the last three or four years of the eighteenth century and the first three years of the nineteenth century. Jackson, in Cape Girardeau County, is in one of the areas, while the other lies in the northern part of Perry County, Perryville, the county seat, lying in the southern part of the area. Between the two groups there are considerable areas of smooth land that is now in cultivation, but was not occupied until after the beginning of the American occupation in 1803. Along Apple Creek there is a considerable proportion of hilly land that is still in timber, but it does not include more than half of the land in this area, the rest being cultivated. Taken as a whole, the Perry-Cape Girardeau part of the Hagerstown belt is one of the smoothest parts of the Ozark region.

Through Ste. Genevieve County and the southeastern part of Jefferson County, the belt is narrow and the topography is rough. There are no large bodies of it that are smooth enough for cultiva-

[1] Includes small areas of Colbert and Decatur.

tion. There are considerable areas of limestone glades more or less overgrown by cedars.

Northwest of Riverside the belt widens and becomes a little smoother. Limestone glades are not so abundant and a large part of the belt is in cultivation. The topography is considerably rougher, though, than in the Perryville area. It is thoroughly cut to pieces by the drainage, but the slopes are not too steep as a rule to allow the soil to be held in place. As Big River and the Meramec are approached the topography is rougher, the valleys are deeper, and the slopes so steep that only a small proportion of the area is capable of cultivation. It is considerably rougher than the belt of Tilsit soils just west of it. On the ridge between the Missouri and Meramec Rivers there is some smooth land in the belt, but throughout the rest of its course it is rough, much like the northeastern part of Jefferson County. There are some smooth ridge stops in this region, but they are covered by deposits of Glacial age which form an entirely different soil series.

The rocks.—The rocks that underlie this belt and from which the soil has been derived consist of three groups or series. The upper series consist of coarse-grained, crystalline, rather soft gray chert-free rock occurring in massive beds usually without any interbedded rocks of other kinds. The middle series consists of thin-bedded, blue to bluish-gray to nearly black, fine-grained compact, usually flint-free limestones breaking with a conchoidal fracture. Interbedded with them are thin laminæ of yellowish to greenish-yellow shales. The lower series is made up of rather massive beds of a dark-gray, finely crystalline, rather hard, flint-free, or nearly so, limestone. The upper two series are of Trenton age, the lower is older, though belonging in the Lower Silurian. The timber growth consists mainly of white oak, red oak, pin oak, walnut, elm, hackberry, linden, and coffee-bean. Ash, post oak, and blackjack are of rather rare occurrence.

The soils.—The soils of the belt are gray to brown silt loams, rarely containing fine sand, and occasional clay loams where erosion has taken away the top soil. The gray soil occurs on the flatter areas and often forms the top inch or so of the gently rolling land.

The subsoil is a brown to faintly reddish brown silty clay loam. Occasionally the subsoil becomes dark reddish brown. Both soil and subsoil are usually flint-free, though where the soil layer is thin it may contain a considerable percentage of limestone fragments.

Throughout the Cape Girardeau-Perry part of the belt the soil layer is usually thick enough, except on rather strong slopes, for the growing of any of the farm crops, including alfalfa. Bedrock is rarely exposed on the upland. Throughout the Ste. Genevieve

stretch glades are more common and the soil layer thinner, except locally. In the rest of the belt glades occur, but not frequently, but the soil layer is often thin. The soils of the belt occurring northwest of Perry County are usually more like the somewhat eroded portion of the Perry County area.

Crops.—This belt throughout its whole extent is occupied almost exclusively by Germans. As is almost invariably the case in Missouri, they are grain growers, not stock farmers. They grow wheat, corn, and clover. The soil of this belt is only fairly well adapted to such a farming system. This series contains some of the best soils of the Ozark region, but none of them will stand continuous cropping like the heavy black soils of the prairies. By the growing of clover, the careful use of what manure the farm supplies, and by careful cultivation in such a way as to reduce erosion to a minimum the Germans are treating their soil about as well as the farming system will allow—certainly much better than the average American-born farmer would do it. It will always be an important wheat, corn, and clover region, but its yields of these crops would be increased in time by more pasture, more manure, and less grain. This is not a region of abandoned nor of run-down farms.

THE ARKANSAS AREAS.

Location.—The largest of these areas, as can be seen from the map, occurs in Randolph and Lawrence Counties, lying just west of the lowlands. The small areas lie in the other counties named above. The map shows clearly the fact that the small areas lie chiefly along the streams, though they are not uniformly wide and the width is independent of the size of the stream. It is not necessary to describe the location of these areas, as they are shown on the accompanying soil map.

Topography.—In the main area, as well as in all the small ones the topography is relatively smooth. The main area is an undulating to rolling plain with a local relief along the creeks of about 125 feet. The slopes are very rarely steep; on the other hand, there is no level land. The greater part of it lies less than 500 feet above sea level. The small areas lie in basins, lower than the country around them. Most of them are merely undulating, not rough enough to be called rolling. Those that lie in a narrow belt along the larger streams are somewhat hilly, especially along the river bluffs. A relatively small part of these areas is too rough for cultivation.

The rocks.—The rocks from which these soils have been derived are limestones and magnesian limestones. They are nearly flint-free and consist in general of two kinds of rock. One of these is a dark-gray to bluish-gray, rather fine-grained, crystalline to sub-

crystalline, massive to thin-bedded rock. The other is a white to cream-colored to pale yellowish, earthy, fine-grained, soft, non-crystalline rock with a conchoidal fracture—a "cotton" rock. It is also flint-free. These rocks are older than the Trenton rock that underlies the northeastern Hagerstown belt and also older than the older part of those rocks, but the character of the rock is near enough alike in the two areas for the soils to be grouped together.

The soils.—The surface soil in the larger area of Randolph and Lawrence Counties is somewhat grayer, as a rule, than the typical Hagerstown, while the subsoil is more of a reddish brown than the typical soil. In other respects it varies from the type less than this. It is a silt with a silty clay subsoil and covers the rock in most places with a layer thick enough for crops, including alfalfa.

The smaller areas have in many cases a more nearly typical Hagerstown soil, but they contain also a large percentage of bare rock or "glade" areas. The soil on the steep slopes along the river hills is everywhere thin and the jagged surface of the limestone is often exposed. In the main area there has been some modification of the soil by intermixture of the sands, gravels, and clays from the Lafayette formation that originally covered a large part of the area. These occur in place only in patches here and there, but their material has been widely scattered.

Native trees.—The common trees found on these soils are red oak, white oak, chinquapin oak, laurel oak, walnut, sweet gum, wild cherry, ash, and cedar. Walnut grows only on the areas of shallow soils or those with rather strong brown or red color. The chinquapin oak and cedar are more common on the "glades." The white oak occurs on the steeper northward hill slopes and the red oak on the average grade of agricultural soil.

Crops.—A large part of the main area of these soils in Randolph and Lawrence Counties has been abandoned. Considerable areas have been abandoned long enough to be overgrown by saplings several inches in diameter. There seems to be no sufficient reason for this in the soil itself. It seems to be due to the development of the lowlands during the last few years and to the advertisements of land agents. The Lowland region has attracted a great many farmers. They prefer to rent Lowland farms rather than cultivate their own upland. The Lowlands are being rapidly cleared up. The land is fresh and its yields are good. The sandy portions do especially well in cotton.

The uplands have been abused by continuous cotton and corn culture, until they do not give heavy yields. While they are fresh, before all their humus has been burned out of them, they give fairly good yields. With a proper rotation, the application of manure, and a rotation with some pasturing, they could be maintained or even

increased in their fertility. The silty soil with its silty clay subsoil makes one of the best foundations in existence for a productive soil. It merely needs care, humus, lime, and possibly phosphorus in time, but not now.

Like the main, or Perryville, area of Hagerstown soils, it should not be devoted wholly to pasture for live stock. It is too good for that, but it is a soil adapted to a combination of grain, live stock, and cotton. At the present time the live-stock industry suffers from the quarantine.

At the present time, therefore, it is a region of cotton and corn growing, with a decreasing yield due to carelessness and a decreasing area of cultivated land. Wheat and oats are both grown to a limited extent.

This area was settled early. Its heavy timber and the absence of stone in the soil attracted settlers, while the lowlands were too wet to cultivate and before roads had been made through them.

Pocahontas Soils.

The Pocahontas soils are closely associated with and are much like the Hagerstown soils. The soil is pale yellowish to light brown in color and the subsoil yellowish or yellowish brown. They are free from stones, occur in areas of smooth to gently rolling topography and are practically all in cultivation. The material was accumulated by residual processes acting on shales, calcareous shales with more or less limestone. They are good general farming soils and are being used as such.

Tilsit Soils.

Distribution.—The south end of the Tilsit soils belt lies against the northern boundary of the southeast Missouri Lowlands in the western part of Cape Girardeau County, Mo. It extends nearly due northward to the south line of T. 35 N., R. 10 E., in Perry County, Mo. The belt of rock from which the soils are derived extends from this point northwestward, but south of Bloomsdale, in Ste. Genevieve County, its outcrop belt is so narrow and so thoroughly and deeply dissected that it ceases to be a determinating factor in the formation of the soils. As a soil belt, therefore, it is interrupted between these points. North of Bloomsdale the belt continues northwestward by Crystal City to Pacific, where it ends as a belt of soils though the rocks continue to and beyond the Missouri in a narrow belt. The general lay and boundaries are shown on the map. A few outliers occur south of the Missouri River in Gasconade and Franklin Counties.

Topography.—Through the southern and central parts of Cape Girardeau County the topography of this belt is smooth to moderately hilly, rarely too hilly for cultivation. The next formation to

the east being of about the same resistance to erosion as the one from which these soils are derived, there is no decided change in topography in crossing the boundary line. The Tilsit area has suffered no greater degradation than the other. As a consequence, the Tilsit soil includes a considerable proportion of the material from this easterly formation. The topography offers favorable conditions for soil erosion. Its yields are not heavy, so that considerable portions of it are allowed to lie idle for two or three years at a time or longer in some cases. It is not a grass soil and the old land has had the humus burned out of it, so that when left idle it is not quickly covered with a sod. The result is a rapid erosion of deep ditches through the fields.

The rocks.—The rock from which the Tilsit soils are derived is a sandstone. In Ste. Genevieve and Jefferson Counties it is gray in color and made up of thoroughly rounded quartz grains with a very small proportion of clay, silt, or cementing materials. In Cape Girardeau and Perry Counties it seems to contain a larger percentage of silt and clay, as well as considerably more iron as a cementing material.

The soils.—The soils of the southern area of the belt, the area in Cape Girardeau County, are brown to yellowish brown in color, with brownish-yellow subsoils, being very much like the Hagerstown soils of adjacent areas. They seem to be influenced to a considerable extent by the presence of Hagerstown material left from an original westerly extension of this material. The soil is mainly silt loam and the area is mostly in cultivation, producing about the same crops as the Hagerstown soils. The soils, however, are considered somewhat inferior to the Hagerstown. Small areas are rather sandy and the sand is much more prominent in the alluvial soils of this belt than in those of the Hagerstown belt.

From the southern part of Jefferson County northward very little of the soil from this formation lies on the parent rock. The topography of the rock-bed changes so that from here northward and westward to where it thins out it occurs on a steep slope. West and south of it the country is lower and smoother, east and north of it higher and rougher. There is, usually, along the extreme eastern border of the lower land a narrow belt underlain by the sandstone, but by far the greater part of the sandstone lies on this slope. The greater part of the lowland is underlain by rocks that differ from the sandstone in character. The higher country is underlain also by different rocks.

The sandstone formerly extended farther west than it does now. It has been placed in its present position by the wear and tear of the elements, but in going back it has left a great deal of its material in the soil. The farther from its existing outcrop, the less is the amount of sandstone material in the soil; the nearer to it, the greater

is this amount. The farther away, the more of the material from underlying rocks, the rocks making the Union series of soils; the nearer, the less of that material. There is a more or less pronounced gradation, therefore, from a soil with a small amount of sandstone material in it in the western and southern parts of the belt to one made up wholly or mainly of that material lying along the foot of the escarpment and upon its face. There is more or less accumulation along the foot of the slope by wash from the front of the escarpment of Tilsit material. The main variations of the soils in this belt are due to this relation of soil location to the front of the escarpment.

The whole belt north and west of central Jefferson County lies either close to the Missouri River or runs across the hill belts along Big River and Meramec River. It is so thoroughly cut to pieces that the smooth part of the belt is reduced to a narrow strip. There is some relatively smooth land along the Big-Meramec watershed, and also along the Meramec-Missouri watershed, but north of the Missouri there is very little smooth land on it.

This belt, like all the others along the eastern Ozark border, is narrow. The main streams draining it flow across the belt and deposit material derived from all the soil belts which they cross. None of them deposit an alluvium derived wholly from one soil group. They are mixtures of materials from several groups.

Crops.—The crops now grown on the Tilsit soils are corn, wheat, and clover. They are moderately well adapted to truck crops, but their location with respect to markets prevents the development of an important truck-growing industry. At the present time, therefore, corn, wheat, and clover are the crops best adapted, and it will grow them with profit provided it is not allowed to wash badly and its supply of humus is kept up by plowing under a crop of clover occasionally.

Union Soils.

Distribution.—These soils occur in a belt folded around the northeastern angle of the Ozark Dome. It begins near the northern boundary of the lowlands in Bollinger County, Mo., and runs northward as a belt of varying width to Franklin County, where it turns westward and finally ends in the eastern part of Cooper County, occurring there, however, only along the stream valleys. The details of the distribution of this belt are shown on the accompanying soil map and need no further description here.

The Union soils are gray, brown, yellowish-brown, reddish-brown, nearly stone-free soils with yellowish-brown to reddish subsoils with gray and yellow mottlings. The subsoils are moderately heavy and in places are underlain at less than 3 feet by a chert layer. The underlying bedrock is a limestone consisting of gray finely crystal-

line beds alternating with argillaceous beds, varying in the amount of clay contained. The crystalline beds contain locally considerable chert in nodules and lenses and all the beds contain small quantities. The soil layer or the layer of disintegrated material is thick enough to cover the bedrock except locally over small areas and on hillsides. Limestone "glades" occur very rarely. The thickness of the soil layer goes beyond the point where it is a limiting factor in crop production.

Topography.—The topography of the belt is rolling to hilly, a large part of it being smooth enough to cultivate. The southern end of the belt in Bollinger and Cape Girardeau Counties is moderately hilly. Much of the upland is farmed, the slopes being gradual enough to permit cultivation. In the western part of Perry County, Mo., it becomes much rougher than in southern Bollinger and remains rough through Perry and Ste. Genevieve Counties. In the southern part of Jefferson County it becomes moderately hilly again, but not so smooth as it is in Bollinger County, though in other respects the two parts of the belt are very much alike. The roughness in Perry and Cape Girardeau Counties is due to the deeper valleys that have been cut into it here than in Bollinger or Jefferson Counties. Saline, Aux Vases, and Establishment Creeks are streams that flow directly eastward into the Mississippi. They are short streams and have steep slopes. They are able to cut deeply into the country on account of this, making the valleys deep. On the other hand, Whitewater River at the south and Plattin and Joachim Creeks at the north do not flow directly into the river, but go into it more or less indirectly and with more or less wayside wandering. Their ability to cut deeply into the country is limited in some ratio to the amount of this indirectness of flow. They do not cut the country up with such deep valleys, nor are the valleys so numerous.

Where the belt crosses Big River it is thoroughly cut to pieces, of course, and the same is the case along the Meramec. On the watershed between the two streams, however, the belt assumes its normal character. West of the Meramec the relief is somewhat less strong than east and south of it, the Bourbeuse itself failing to cut deeply into it. Nowhere along that stream is the relief as great as it is on the Meramec or in Ste. Genevieve and Perry Counties.

Westward through Franklin County the belt of Union soils becomes smoother, being smoothest in the lower parts of the basins of Boeuf and Berger Creeks. On the Bourbeuse the topography is nowhere flat or even smooth, neither is it very rough.

The rocks.—The rocks from which the Union soils are derived are the Jefferson City limestones, a series of moderately cherty argillaceous and more or less shaly and thin-bedded limestones.

Native trees.—The native tree growth consists almost entirely of white, red, black, and post oak, with walnut, elm, and other soft-wood trees occurring on the rolling browner lands.

The soils.—The Bollinger-Cape Girardeau stretch has a soil belonging to the gray, nearly stone-free phase of the group. The subsoil at the top is pale yellow to gray, becoming reddish downward and in places a deep reddish brown. This latter color prevails where the subsoil lies around one of the grayer, more crystalline of the rock beds.

Chert occurs in the subsoil, but is not uniformly distributed, occurring in patches. This is also true of the chert in the soil. The cherty spots are usually on brush or timber-covered knolls and on steep hillsides. The soil is a silt with silty clay subsoil. The country is thoroughly but not deeply dissected. The ridge tops are uneven, giving an irregular, choppy effect to the topography. Cultivation extends to all the valley lands, the gentler slopes, the ridge sags, and some of the ridge tops. This distribution of field and forest harmonizes with the topography, both contributing to the characteristically varied appearance of the country. The timber, except on the stony patches, contains a large proportion of small white oak, but includes the other oaks, post oak occurring rarely, however, and blackjack not at all. Farther north toward the headwaters of Whitewater River around Patton there are considerable areas of rather smooth land. In the valley basin or the lower uplands along Whitewater above and below Patton the soil has a stronger color (more red in it) and is more productive. The timber growth on these redder soils includes a larger proportion of walnut and elm than elsewhere. White oak is still a common tree on the uplands and on the moist northward slopes. On the narrower ridge tops the soil is gray to pale yellowish brown, with no strong red in the subsoil.

The more rolling land in this belt washes badly where neglected. Abandoned fields are not at all uncommon. They soon become badly scarred by gullies—deep enough to make cultivation difficult.

The only kind of farming carried on is general farming, including wheat, corn, oats, timothy, and some clover. The yields are low. The land deteriorates rapidly, chiefly because of its rapid erosion as well as because of the fact that the hill land is not grain land. It is not strong enough for continuous or frequent grain cropping. The land is grass land and the country is a sheep and cattle raising country. Small fruit does fairly well, but only a small part of the total area of the land can be devoted to growing it.

The Perry and Ste. Genevieve portion of this belt is too hilly for farming, except in a very small way. The bottom lands, like those farther south, are fertile, but their area is small. The uplands occur as narrow ridges or hill slopes. The soils are gray to yellowish brown and the subsoil yellowish brown. The cherty layer beneath the soil

is exposed in the roadside ditches and is locally cemented into hardpan. It is also exposed in the fields in the form of flint patches here and there. The more active erosion, oxidation, and leaching in this part of the belt removes the upper more silty soil material in most places as fast as it is formed. The organic matter is pretty well burned out, and the color is leached out to gray or pale yellow or brownish. The soil is therefore cold and its moisture relations poor. It is not a prosperous agricultural region, no new land is being cleared, some that has been cleared many years is being abandoned, and what cultivation is being done is half-hearted.

It is less of a grain soil than that of the Whitewater country. Clover does not grow with marked success and its timothy meadows are often overgrown with trailing briers. It is a typical cold gray to yellowish clay land, starving for humus.

In southern Jefferson County the belt continues hilly, gradually becoming smoother northward. Its soils are somewhat better than farther south, chiefly because of the less active erosion and leaching. It continues to be, to a considerable extent, a country of small white oaks and scrub oaks. Around De Soto it is somewhat more cherty than farther south, is rather shallow, and has a little stronger color. West of Big River around Grubville and northward it is typical gray, white-oak silt, much like the southern part of the Whitewater country, is occupied chiefly by Germans, to a somewhat greater extent than the latter, and is somewhat better cared for.

West of the Meramec River near Saint Clair and northward the topography is smoother, the soil has a little darker color, and a larger proportion of it is in cultivation. The percentage of chert in the soil and subsoil is small and the subsoil is rather heavy but moderately well oxidized. The farmers are more prosperous as a rule than farther south. The timber growth changes slightly, the proportion of red oak, hickory, and post oak becoming larger.

The belt divides in the western part of Franklin County, one arm extending up Bourbeuse River, the other westward along the Mississippi.

In the Bourbeuse belt the soil is darker than farther south, with less tendency to a yellowish-gray color, except on the post-oak flats. The soil is rather shallow on the slopes and bedrock is often exposed, but limestone glades are of very rare occurrence. The subsoil, especially on the slopes, has more red in it. The slope land, of which a considerable portion is not too steep to cultivate, is decidedly stronger than the average of the series. It includes considerable areas of rolling land, with patches of dark silty clay with gray, brown, or bluish clay subsoil, and supports a vigorous growth of laurel oak on the moister and white oak and hickory on the drier portions. The belt becomes narrow upstream, being narrowed by the encroachment of the adja-

cent post-oak flat lands. Cherty areas are irregularly distributed here and there, due apparently to the local distribution of the chert in the limestone. The timber growth on the rolling lands is more vigorous than farther south, except in the vicinity of Patton, where there is some large white-oak timber.

The northern branch of the belt, extending westward from Washington, lies chiefly in the St. Joseph, Boeuf, and Berger Creek basins. It lies on the same series of rocks as those underlying the belt farther south, but occurs in basins surrounded or nearly surrounded by higher country with different rocks, which in the not distant past extended over these basins themselves. The soils are mixed with more or less material coming from these higher rocks. One of these overlying rocks is a sandstone and another is a layer of silty clay.

The soil of the northern belt is a brown to reddish-brown, rarely gray, stone-free or nearly stone-free silt to silty clay loam containing varying proportions of sand; usually small, except in a narrow belt on the higher lands close to the outcrop of the sandstone. The subsoil is a yellowish-brown silty clay with no sharp line between soil and subsoil. The underlying rock ledges are occasionally exposed in roadside ditches and steep slopes, but rarely in the cultivated fields. Chert is of rare occurrence in the soil, but may be seen in the roadside ditches.

This is a stronger phase of this soil than occurs anywhere else within the belt. It resembles the typical brown loam (Knox silt loam) in its texture and in its crop value.

The change from the normal soil to the Boeuf Creek phase takes place gradually, seeming to depend upon the distance from occurrences of the overlying sandstone and clay beds. The sandstone does not affect the soil to a great extent east of New Haven.

Throughout the whole extent of this branch, as well as the main belt running southward from Union, the sandstone formation, with its soils, lies adjacent to it on the east, which causes more or less modification of this soil on its extreme eastern boundary throughout its extent.

The westward extension of the belt is almost cut off in Gasconade County by a northward extension of the Owensville and Lebanon soils. It widens, however, before the Gasconade River is reached and appears as a somewhat different phase, but not different enough to warrant a separation into a new group. This phase extends westward across Osage, Cole, and Moniteau Counties and into Cooper County, and southward into some portions of Miller County. It contains small areas and belts of Owensville soil distributed here and there on tops of its highest points. The belt extends southward to an irregular line lying not far north of the Rock Island and Pacific Railway.

The soil is a chert-free gray to yellowish-brown silt to clayey silt with more gray and yellow and less brown than the Boeuf Creek phase. The subsoil is grayish yellowish brown to reddish, but usually paler than in the eastern part of the belt. The country rock, a thin-bedded argillaceous to finely crystalline magnesian limestone with a small amount of chert, outcrops rather frequently on steep slopes, but very rarely in the fields. The soil layer is occasionally thin, but limestone "glades" do not occur typically.

The native timber includes a larger proportion of white oak than the Boeuf Creek phase. It occurs abundantly on the northward slopes. The southward slopes grow black, red, and chinquapin oak. There are occasional walnut, elm, coffee-bean, linn, and hackberry trees, and a great many shrubs, such as hornbeam and viburnum, the latter occurring on the south slopes on areas of shallow soil.

The topography is rough. The country is more thoroughly cut to pieces than anywhere else within the belt, except in the Perry County stretch. The topography is, however, not so angular as the latter. While almost no flat upland is left, the slopes are more rounded than in that county. The depth of dissection varies from a maximum of 250 feet along the Osage and Gasconade Rivers downward. The shallowest dissection occurs on the upper Moreau Creek in Moniteau and Miller Counties.

None of this area of Union soils, except a narrow belt east of the Gasconade River, has been modified to any appreciable extent by the sandstone referred to in the Boeuf Creek area. The sandstone does not seem to have extended over this region since the beginning of the formation of the existing soil. The silty clay formation referred to in the same place, the formation from which Owensville and Lebanon soils are derived, did extend over the area and has had considerable influence in the soil making. It is not at all improbable that a considerable proportion of this soil has come from that source.

From Jefferson County northward and westward this belt is occupied almost wholly by Germans. South of Jefferson County there are a considerable number, but they do not make up the total population. They came into the Boeuf Creek area somewhat earlier than in the others, but they have been established in all of them for half a century. They are grain farmers with a special liking for wheat. They all make an effort to grow clover, and up to within the last 10 years they have succeeded. Since then, in parts of the area, especially in the Osage-Cole section, the growing of clover has become progressively difficult. Stock raising constitutes a small part of the farming scheme, but less attention is paid to raising cattle, sheep, and horses than to hogs and poultry.

The growing of apples and grapes in the Boeuf Creek area is engaged in to some extent, but there are no large orchards. In southeastern Franklin County apples are grown commercially in a small way.

The farms are fairly well kept. The farm houses are modest and simply constructed, but kept in good repair. New style cottages and elaborate houses are both of very rare occurrence. The building material in the eastern belt is wood, in the Boeuf Creek area wood and brick, and in the Cole-Osage area wood and stone, with brick along the Missouri River. The Osage-Cole area contains a considerable number of large, well-built stone and brick churches. The village streets are clean and the houses kept well painted and repaired. The yards are inclosed in massive stone walls and usually well covered with sod. It is a region filled with people who are content with a plain but comfortable living.

Clarksville Soils.[1]

Distribution.— There is one main area and one subordinate area, the latter of considerable size, of Clarksville soils in the Ozark Dome. The main area occupies a large part of the east-central part of the region, reaching north and south from near the Missouri-Arkansas line to near the Missouri River, with an east and west extent only a little less. It extends as a belt entirely around the area containing the Fredericktown and associated soils, the eastern arm of the belt being very narrow, however. The subordinate area lies in Camden and adjoining counties in Missouri. It is roughly circular in outline.

Topography.—As a whole, the areas of Clarksville soils are the most thoroughly dissected of any of the important soil areas of the Ozark Dome. There is no smooth upland soil in either area. They include that part of the Ozark Dome that has been subjected to the most thorough dissection, although, like the most of the region, the tops of the ridges lie essentially in a plain. On account of the uniform character of the rock underlying both areas there is no variation in the type of dissection, different areas differing merely in the depth and very slightly in the thoroughness. The areas were originally a simple plain, and in its thorough dissection it has retained its simplicity so far as type of relief is concerned. Practically the whole upland of both areas is too rough for cultivation, except in small areas.

The rocks.—The rocks underlying both areas are a series of limestones consisting mainly of massive crystalline beds, alternating with thin-bedded argillaceous to finely crystalline beds. They are all more or less cherty, the upper beds being more cherty than the lower, so that when the area is exposed and has formed soil at all it has the abundant chert from this upper layer or a large part of it that has

[1] Mainly stony loams.

settled down onto the lower beds, where these form the soils, from these overlying beds, by the washing away of the fine materials.

The chert occurs in a great variety of forms, all of them irregular, and is always cryptocrystalline rather than chalcedonic. It is gray in color and occurs mainly in irregularly shaped masses, in lenses, and in massive but discontinuous beds.

The limestone beds are alternately massive and thin bedded, probably about half of each kind; the massive beds are almost free from chert; the thin-bedded rock is in places almost entirely replaced by it.

The massive beds disintegrate into a brown to reddish-brown silty clay, practically free from chert, but it becomes mixed in all cases with the chert from higher cherty beds of the same series, so that, except locally, the soils of the whole series is extremely cherty. The great body of the chert, especially of the thick, brecciated beds, lies in the upper part of the formation. This becomes strewn over the surface and mixed with the soil from the whole vertical thickness of the rock.

Within the formation, in addition to the rock already described, there is a bed of sandstone having a wide distribution as a geological formation but varying greatly in thickness. This is not great enough to cause the formation of a true sandstone soil, except in the area in Dent and adjoining counties, which is identified and described in this report as the Dent soils. Elsewhere it merely modifies the cherty limestone soil.

Native trees.—The area of Clarksville soils is an area of forest and will continue to be such, except in case of the narrow valleys and a very small part of the upland. It is an area of oak and pine. The oak is almost exclusively made up of red, black, and white oak. The black oak grows on the stony ridge tops and on the southwardly facing slopes, as on the dry, undulating stony areas, wherever they occur. White oak and red oak occur chiefly on the northwardly facing slopes and in deep narrow hollows, where the soil is moist and the stone content somewhat lower than on the opposite slopes.

The pine is the shortleaf yellow pine. It grows on the drier soils, on the southwardly facing slopes, on dry, stony ridges, and in areas where the soil contains a considerable proportion of sand.

The soils and crops.—The greater part of the soil of the Clarksville stony loam is a gray, very stony silt loam with a gray, pale-yellowish to reddish-brown stony silty clay subsoil. Large areas of it would be nothing more than Rough stony land if mapped in detail. Taken as a whole, the upland soils can not be cultivated with profit. It is and should remain a forest area mainly. On the narrow ridge tops and in small areas, especially the northwardly facing slopes, where the stone content is small, small farms have been established and the

ordinary grain and hay crops are grown. Where the soil is gravelly, especially the northwardly facing slopes, clover does fairly well. On the narrow ridge tops where the soil is a silt loam with sticky clay subsoil and where the stone content is small, clover does not do well. The area can never become an important agricultural region, but the smoother and less stony parts of it may be utilized.

The type of settlement on the Clarksville soils is characteristic. Instead of being distributed uniformly over the area or in blocks it is in strings. The farms are strung along the creeks, so that a map showing the distribution of the houses and cultivated land would serve also as a drainage map. In the few cases where settlement is not strung along the valleys it extends along the watersheds, bringing out, even in this case, the drainage.

Within the Ozark Dome there are a little more than 6,500 square miles of Clarksville soils, an area equal to about a tenth of the whole State and about a fifth of that part of the Ozark region lying within the boundaries of the State of Missouri.

The crops grown within the Clarksville area, almost exclusively on the bottom lands or Alluvial soils (mainly Huntington), are corn, wheat, clover, and timothy.

Little attention has been given to alfalfa, though there is very little doubt about its success with proper attention, on the gravelly well-drained soils especially. The yields of both corn and wheat are good, while clover and timothy do well.

Iberia Soils.

Distribution.—These soils occur in narrow belts running parallel to most of the streams of the Gasconade and Osage Basins. They are "bench lands," occurring on relatively smooth benches lying above the stream levels at elevations varying from stream level at the heads of some of the streams up to 300 feet above the streams as a maximum. On one side of each belt the country drops to the stream flood-plain level through a belt of thoroughly dissected country; on the other it rises to the level of the main upland. This varies from a very few feet to 200 feet. On both sides the benches are bounded by strips of dissected country, lying below the Iberia level on one side and above it on the other. The width of the Iberia belts varies up to a maximum of 8 or 10 miles. Along most of the streams they run from 1 to 3 miles in width. They are best developed in Miller, Maries, Phelps, Pulaski, Laclede, and Texas Counties. On the Meramec and Bourbeuse they are not typically developed.

Topography.—Practically all of the area of this series of soils is smooth. The rock series from which it is derived is thin. It can have, therefore, very little vertical range. Where valleys have been cut into the belt, the Clarksville stony loam occurs in them. Where

hills occur on the belt, the Howell soils occur on them. One can only remain within the area of the series by keeping on about the same level. The maximum local relief that can occur is the thickness of the rock series, which is not more than 100 feet. It is usually less.

The detailed distribution of each type of soil in the series can not be taken up in a general report, even if it were known. Only the general characteristics of the soils in the several areas of occurrence can be given.

The benches are wider and include, therefore, a larger area in Miller County than anywhere else. They are well developed on both sides of Tavern Creek and its branches. The largest area occurring anywhere in one body lies north, east, and west of Iberia. The general distribution here can be seen by consulting the map. The soil is gray to brown and usually free from real hardpan. The stone layer occurs beneath the soil layer of the stone-free soils, usually within less than 3 or 4 feet, but it is rarely cemented. The subsoil is more often brownish or reddish than gray or white. Drainage conditions are favorable. Along the borders of the belt here, as well as everywhere else, the soil is more stony than in the interior of the belts. Limestone glades, having only a very small extent, occur in places, but areas where the soil is shallow have a wider distribution and are larger. On such areas the soil is often black to dark brownish black and supports a growth of walnut and elm along with oaks. Such areas occur only in sags and at the heads of hollows.

Occasional small patches with a gray silt soil, a reddish-brown clay subsurface, and a mottled silty clay subsoil, very much like the Putnam silt loam, occur.

Little Richwoods settlement was made in the Iberia area of these soils before 1840 and the soil was considered fertile. The settlement seems to have been located not far from Ulman. The whole region between Iberia and Ulman is now known as the Richwoods region.

Extending up the several branches of the Tavern and Maries Creeks there are tongues of these soils, some of them reaching nearly to the watershed at their heads.

Along the Gasconade River from the south line of Osage County two belts, one on each side, extend continuously up into Laclede County on the Osage Fork, Wright County on the Main Fork, Texas County on Roubidoux Creek, and nearly to Gapool on Piney Fork. There are belts along the upper branches of Jacks Fork of Current River in Texas County also. The benches become more or less obscure around the headwaters of the Gasconade, but they are distinct around the headwaters of Piney Fork and Jacks Fork.

Throughout the length of these belts they are narrow and ragged at the edges, especially the one next the river. Where two belts meet around the lower end of a ridge separating them there is a wider

and smoother area than usual. Licking, in Texas County, is in such an area, the general lay of the place being somewhat like Iberia.

The rocks.—These soils are derived from a series of fine-grained crystalline and noncrystalline, partly argillaceous, cherty magnesian limestones. They contain a small amount of flint and thin shale layers occur occasionally. Where the soil is derived from the latter beds alone it is a stone-free gray silt with stone-free silty clay subsoil varying in color from gray to reddish brown, according to the particular layer of rock from which it has been derived and the drainage conditions; where it is mixed with material from either rocks lying below this series or above them it is cherty. In the former case it is usually more cherty than in the latter and the subsoil is apt to have more chert, a grayer color, and a higher percentage of silt than in the latter case. In the former case the native tree growth will vary with the percentage of stone in the soil from that on the "hickory bench" land as described above to almost exclusive black jack on the gray dry stony land. In the latter the trees are post oak, or post oak and black oak. White oak occurs, but it is not an abundant tree.

Native trees.—The native timber growth is black oak, red oak, and hickory. The natives in parts of the region call such land "hickory bench" land. It is about the most productive upland soil in the central Ozark region south of the Gasconade River and is easily cultivated.

The soils vary considerably in character, but agree in topographic position, origin, and geological relations. They range from stone-free to moderately stony, from shallow to deep, from gray through brown to black in color in the soil and from gray through yellows to reds in the subsoil, and from friable red clay through gravelly and stony clays to hardpan subsoils. The differentiation of the group is based on topographic position rather than on soil characters. The gravelly soil is closely related in origin to the Clarksville soils, but has usually more red in the subsoil. The silty stone-free soils are essentially the same as the Howell soils, but the dark-colored soil is of rare occurrence in the other areas, except in the Berryville, where it is of rather common occurrence. In nearly all cases where the surface soil is stone-free silt it lies on a layer that is harder, denser, and more impervious than the silt. Where the soil is gravelly and the subsoil is gravelly to stony there is no change in permeability from the surface downward.

Of these soils the black clay loam with no hardpan under it, occurring almost exclusively in the northwestern areas, is the most fertile. The gravelly gray to brownish silt loam with brownish to reddish-brown gravelly to silty clay subsoils growing black oak and hickory ranks next in value. Following this the gray gravelly soil with reddish-yellow, gray, or brown gravelly to stony subsoils, growing blackjack timber, ranks third, while the gray silts with gray, pale-

yellow to brown silty clay subsoils, both with and without the hardpan layer, all growing post oak trees, stand at the end of the list.

All of these soils are occupied largely by farmers of American lineage. At the northern end there are some Germans, but they have not spread far southward.

There is practically no effort to adapt the cropping system or the agricultural practice to the soils. Throughout a large part of the area grain farming is attempted, but the results are not entirely satisfactory. The yields are low and cultivation often difficult. Except on the best land like the Iberia area grasses do not do well and not much attention is paid to clover. It would not be a profitable crop on the gray silt lands, but would do well on the gravelly lands. Even on the best land too large a proportion of the hay crop is timothy and too small a proportion is clover. It is destined to be a general farming region for some time to come, however well the soils might be adapted to special farming, such as fruit growing, trucking, or dairying. The transportation facilities settle this matter for the present with no appeal. Fruit growing has been attempted on the land where it is crossed by the Frisco Railway, but it can not be claimed that the venture has been successful. The trees will grow, but late spring frosts often injure the crop. Even if they did not do so there could be no change in the farming system of the area as a whole because of distance from a shipping point.

The soils, climate, transportation, and state of agricultural development now reached by the region as a whole make live-stock raising the most profitable system of farming that can be engaged in. The human factor is more easily adjusted to this than to any more specialized system of farming. As the region adapts itself to animal husbandry, specialized forms, such as dairying, breeding, and feeding can be gradually adopted. This applies not only to these soils but to all the others of the interior of the Ozark region. Animal husbandry will not only restore the original fertility of the soil, but it will make it more productive than it ever has been. It will also enable the farmers to utilize a great deal of land that is not being utilized at the present time.

The post-oak lands would be improved by the addition of lime. With humus, lime, and drainage this soil would be much better, but the disadvantage arising from the hardpan can not be easily overcome. There is no known method of breaking this up that is adapted to low-priced lands.

Lebanon Soils.

Distribution.—The Lebanon soils are the ridge-top soils of the Ozark Dome region. They occur in small areas over practically the entire region, but have been differentiated and shown on the map only in

that part of the region where they occur in considerable areas. They occur in the largest areas in the Gasconade and Bourbeuse region, along the western part of the Dome from Greene County northwestward, and on the level uplands of southwestern Missouri. Essentially the same soils have a wide distribution in northwestern Arkansas, but they have been mapped as the silt loam soils of the Fayetteville series.

The distribution of these soils shows their occurrence to be confined mainly to the smoother parts of the Ozark Dome. The smooth watershed plateaus of Texas County and the smooth uplands of northern Phelps, northern Crawford, and adjacent parts of Gasconade and Franklin Counties are covered with them. In the latter counties especially they seem to be associated in origin with the Owensville soils. Large areas of country where the soil layer down to 12 to 20 inches is essentially the same as the Lebanon soils, but with a gravelly or stony clay subsoil, occur in Laclede, Dallas, and Webster Counties.

Topography.—The topography of the country in which this soil occurs is uniformly smooth, either flat or gently undulating.

Rocks.—The rock from which the greater part of this soil has been derived has disappeared entirely. The soil is therefore a remnant of a layer of material, either consolidated or unconsolidated, which originally lay over the whole region in which the soil occurs, and probably over a much wider one. It is not at all improbable that the material has been derived from different sources at different places. In the whole western part of the region there seems but little doubt that it is a remnant of the Coal Measure shales and clays that originally extended over this region. In the Gasconade-Bourbeuse region there is no doubt that it is a remnant of the layer of material from which the Owensville soils are derived. This latter may be either a remnant of Coal Measure shales and clays or it may be the southward extension of the glacial clays of the north Missouri plain.

Native trees.—The characteristic tree is the post oak. Black-jack occurs abundantly also, especially where the underlying gravelly clay lies within a foot or two of the surface. Other oaks and hickory occur to some extent.

The soils.—The predominant soil is a silt loam, universally gray in color and low in organic matter. The subsoil is uniformly a heavy sticky silty clay, gray to yellowish in color. This extends to a depth varying with the locality from 1 foot to 5 or 6 feet or more. Beneath the clay layer lies the stony or gravelly clay of the typical Ozark region, a residual product of the decay of the cherty limestones.

There is a concentration of stony material within the first foot below the clay layer. The concentration may have taken place before the clay layer was deposited. Beneath this layer the material is a red clay with stones. Where the stony layer lies within a foot or

two of the surface it is often, probably usually, cemented into a hardpan. This does not permit the downward percolation of the rain water nor the upward rise of the deep water of the substratum. The soil in such cases is both droughty and poorly drained. This phase of the soil occurs much more abundantly in the Gasconade region and in the southern part of the Bourbeuse region than in the other areas. It is less common in the western than in the southwestern areas, though it is not common in the latter. Where this soil layer is thick and the hardpan absent it produces fair crops, except in those areas that are entirely flat. It is only moderately productive and has to be handled carefully. Its most evident deficiency is vegetable matter. Where this is abundantly supplied its productiveness is greatly increased. The shallow areas and those with hardpan produce very light crops; only about 15 to 20 bushels of corn and 5 bushels of wheat per acre are obtained. Not a large part of these areas is in cultivation and considerable areas that have been cleared are now abandoned.

Owensville Silt Loam.

Distribution.—The Owensville silt loam occurs mainly in the extreme northwestern corner of the Ozark Dome, with small areas in the Bourbeuse region in Gasconade and Franklin Counties. It is the typical upland soil of Miller, Morgan, Cooper, Moniteau, and eastern Pettis Counties. The Miller County area and the Gasconade County area are fragments of a belt that was originally continuous along the whole northern border of the Ozark region. This soil is a foreigner in the Ozark region, being much more closely related to northern and western Missouri than to the typical Ozark country. It is in fact an overlap from these regions.

Topography.—The topography is uniformly smooth, either level or gently rolling.

Native trees.—This was a treeless region until it was placed in cultivation.

The soil.—The soil is mainly a silt loam with more or less clay loam. It is gray to dark gray, becoming somewhat lighter in color at about 12 inches or in the lower 3 inches of the upper silt layer. Beneath this upper layer, at a depth varying from 6 to 16 inches, is a layer of heavy plastic clay, mottled dark reddish brown and gray or yellow. This layer is usually about 6 inches thick, passing rather gradually into a layer of silty clay mottled brown and gray, sometimes a nearly uniform yellowish-brown color. The layer of heavy clay outcrops in banks and gullies as a brown clay and the silty clay layer is in the outcrop more yellow than when not exposed.

Crops.—This is a good wheat and corn soil, except when poorly drained or when its store of organic matter is especially small. It is all in cultivation, having been broken early in the settlement of the

country; not so early, however, as the alluvial lands or the brown walnut and elm lands along the Missouri River. Bluegrass does well and most of the hay grasses produce good crops.

Howell Soils.[1]

Distribution.—The Howell soils occur widely distributed over the Ozark Dome region. The general distribution is in the form of a broad, ragged belt extending from the northeastern part of the Ozark Dome westward, southward, and southeastward along the northern, western, and southern parts of the area, and ending against the Mississippi River lowlands in southeastern Missouri and northeastern Arkansas. The belt is bounded on its eastern side by the Clarksville stony soils and on its western and southern sides by the Springfield soils. The general belt includes areas of some of the other soils of the region, especially Berryville, Union, and Clarksville soils.

The distribution is shown on the accompanying map and need not be described in detail.

Topography and general conditions.—The Howell soils area is a large one, stretching across the Ozark Dome from its northern to its southern borders. In covering so wide a stretch of country it could hardly be uniform in its characteristics. Its soils vary between rather wide extremes. As a whole its agricultural conditions are nearer uniform than are its soils. In general its soils are less cherty than the Clarksville and its topography is less rugged. Its soils are also somewhat less cherty than the Springfield and its topography is somewhat rougher. They are grayer in color also, or at least they contain a much smaller percentage of red and brown than the Springfield, and where these colors occur they have a yellower tinge than those of the latter group.

The topography consists essentially of long, narrow, flat or rolling plateaus separated from one another by hill belts lying along the streams. These latter vary widely in their thoroughness and depth of dissection, though taking the area as a whole the dissection is less complete and less deep than in the Clarksville or the eastern parts of the Springfield areas. The soils are less productive than the Springfield soils, and the area as a whole is less capable of cultivation; they are more productive than the Clarksville soils and the area is much more capable of cultivation. In value the area lies, therefore, intermediate between the Clarksville and Springfield areas. It is a region of moderately cherty, gray, brown, or reddish soils occurring in a region of alternating hilly and smooth belts.

The rocks.—The rocks are gray, rather heavily bedded subcrystalline cherty limestones and magnesian limestones. The chert occurs

[1] Includes some Clarksville.

sometimes in large concentrically arranged nodules. They are lens-shaped bodies from 6 inches to 15 inches thick and from 2 to 5 feet in diameter. By the time they are weathered out, however, they are broken up into a large number of fragments. They are recognizable among the soil fragments by their structure. Chert occurs also in smaller nodules and in masses. As a whole the chert of the group is more dense and quartzitic in character and higher in silica than is that of the Springfield or of the Clarksville soils. This applies especially to the concentric, banded, nodular, and oolitic chert. The more massive and amorphous chert is much alike in all three groups, but its occurrence is much less common in the Howell soils.

In the southern part of the area there is a very large amount of a gray crystalline, porous and somewhat cellular chert, weathering to a very light gray color and breaking up into fragments of a pound weight—or somewhat smaller on an average—of irregular shape and with a rough surface. It occurs mainly on the surface, is not found in place in the underlying rock, and does not occur in the subsoil. It is a foreigner in the region at the present time, a derelict of a former time, when the country was a few hundred feet higher than it is at present. It produces a very cherty soil with a much less cherty subsoil.

Soils in general.—In the Howell soils taken as a whole there is more stone (chert) on the surface and in the first few inches of the soil than in the subsoil. There are some variations from this, however. On some of the high ridges in the northern part of the belt there is a layer of 6 to 10 or 12 inches of soil on the surface that is practically a stone-free silt. Beneath that comes a layer of stone about a foot thick and below this the less stony, though not stone-free subsoil. In other areas the difference is not so marked and in still others it is even more strongly marked. In the Clarksville and Springfield soils, on the other hand, the subsoil is, for several feet down, cherty.

The Howell soils are gray, usually. Occasionally they are pale yellowish brown or yellowish red. The subsoil or substratum is always red. The upper part of the subsoil may be gray, pale yellow, yellowish red, or yellowish brown or pale reddish brown. The subsoil has a rather higher percentage of clay than the subsoil of the typical Clarksville soils. The upper part of the subsoil, where not gray, has more yellow in it than does that of the Clarksville soils.

The whole belt can be subdivided into a number of separate areas, within each of which conditions are similar, though these conditions differ from those in the other areas. The several areas are differentiated mainly on the basis of topography and proportion of flint or chert in the soil.

The subdivisions sufficiently well marked to be roughly outlined during a rapid reconnoissance of the region are: (1) the Westplains areas, (2) the Hartville area, (3) the Lebanon area, (4) the Rolla area.

THE WESTPLAINS AREA.

This area lies at the extreme southeastern end of the Howell belt. It includes parts of both States, lying in Howell, Oregon, Ripley, and Carter Counties in Missouri and in Baxter, Fulton, Sharp, and Randolph Counties in Arkansas. Its eastern and southern boundaries and parts of its western and northern boundaries are soil-group boundaries. Its northern boundary lies a short distance north of the St. Louis & San Francisco Railroad as far east as Low Wossie. It bends thence westward and southward around the rougher Clarksville country along Eleven Point River to the vicinity of Thomasville and thence runs eastward to Poplar Bluff, Mo. South of the State line the eastern boundary is the group boundary and needs no description. The same is true of its southern boundary and part of its western boundary extending as far north as the vicinity of Gainesville, Mo.; thence it runs northeastward to Sterling, on the St. Louis & San Francisco Railroad, where it meets the western end of the northern boundary. North of the general boundary thus described other areas are known to occur, but they are small and have not all been located on the map. The area thus outlined possesses very pronounced characteristics. It is more sharply and definitely differentiated from the other areas of the Howell belt than are the other areas from one another.

Topography.—The region has two very definite and pronounced characters of topography and soil. In the one case the topography is gently undulating. The stream valleys are shallow. The small streams lie in mere sags and a great many of the smaller drainage lines end in broad, shallow sags with no surface outlet. The usual drainage maps of the region show a large part of this area blank, as though no drainage lines existed. The facts are that they exist, but are not pronounced, and many of them end in basins without surface outlets. The latter range in size from a few feet to half a mile in diameter. They are usually less than 50 feet lower than the rim surface around them. They are approximately saucer-shaped, with an opening at some point into an underground channel through which they are drained. Many of these outlets become temporarily, and occasionally permanently, closed, converting the basins into ponds.

The rocks.—The rocks underlying this part of the area are cherty limestones.

Native trees.—The predominant tree is red oak. With this is mixed hickory, black oak, white oak, and post oak. Hickory and black oak constitute the main body of the subordinate forest trees. The

growth of timber is usually strong. The trees are not large, the average maximum diameter being about 10 to 12 inches, but the stand is thick on the ground, and the trees tall and healthy.

The soils.—There are three soils within the area, the differences between them being partly topographic and partly soil characteristics. The principal soil differences are those of color of soil and subsoil and the content of stony material in the soil. The most fertile soil in the area, so far as general farm crops are concerned, is what is called the Howell gravelly loam.

Howell gravelly loam.—The soil is gray to brown in color. Where the gray is a rather light gray the top of the subsoil has a faint yellowish tinge. Where the timber contains a considerable percentage of hickory the soil is dark gray on the surface, occasionally dark enough to be called black.

The subsoil is reddish brown to red. This is the typical subsoil color, but in some leaching has changed the color to grayish. The substratum is red.

The soil is gravelly rather than stony, while the subsoil is usually nearly stone free. The whole soil and subsoil are therefore nearly stone free, but not gravel free, the term "gravel" being used for small stones up to 2 inches in diameter. Like all the Ozark soils, there is no layer of black humus-filled soil; even where blackest the black part is less than an inch thick. The main difference between soil and subsoil is one of a change from gray to brown or red. Where the surface soil is brown the change to the deeper color in the subsoil is gradual.

The crops.—These soils are fair general-farming soils and, with the exception of the bottom-land types, they are the strongest soils that occur in the Westplains group. Clovers grow well on them and they produce fair crops of corn and wheat when carefully cultivated. Timothy does fairly well on the less stony soils and especially well on northward slopes. The greater part of the area of these soils that is now in cultivation has been cultivated for many years.

Howell gravelly loam, stony phase.—Associated with the gravelly basins are knolls and low ridges that are extremely stony. They contain large fragments of chert from the bedded chert, as well as usually a considerable amount of the porous inherited chert. They lie only a few feet higher than the gravelly land, but they are prominent enough to be noticeable features, mainly because of their stone content rather than their elevation. They usually have a subsoil much like the gravelly land and support a good strong growth of red-oak timber. With the gravelly loam there is found a gray soil usually grayer than the gravelly loam, with a yellow to pale-reddish subsoil, very stony, occurring on the uplands and on the stony slopes. It is therefore both a rough-land soil and a smooth-land soil. Its main area of occurrence is in Howell County,

Mo., and Fulton County, Ark. It occupies a considerably larger area than the other main type. It is not so exclusively characteristic of this area as is the other soil, since it occurs in small areas in other parts of the main Howell belt, but it is especially characteristic of this because of its large area and wide distribution.

Topography.—As stated above, it occurs on the smooth ridge tops and in rougher areas. It occupies the dissected areas of Bennets Bayou, Spring River, and a narrow belt along the head waters of streams flowing into North Fork of White River. Their topography is not rough in the usual Ozarkian sense, but it is rougher than the ridge tops and the basins of red-oak soils. The valleys are rarely more than 125 feet deep and the slopes are gentle, often not too steep for cultivation.

The rocks.—The rocks underlying these soils do not differ markedly from those previously described within the area. Those in the more hilly areas are a little more cherty, while those on the ridge tops are essentially the same, the differentiation being a function of leaching, amount of chert, exposure, and native trees.

Native timber.—The predominant tree is blackjack. Associated with it on the ridge tops are post oaks and on the slopes are black oaks.

The soils.—The soils on the ridge tops vary from stone-free or nearly stone-free gray silts, with post oak as a prominent tree, to very stony gray silt with blackjack oaks. Except when the silt has accumulated in basins the subsoils are always same shade of yellow. The deeper subsoil or the substratum is reddish brown, but it is usually a lighter red than that of the other soils, owing probably to the greater amount of yellow present. This soil is essentially the same as the Clarksville soil.

On the rougher land the soil has a gray to light reddish-brown color and varies considerably in the stone and gravel contained, but is always stony. The silty, ridge-top type occurs in small patches in these areas, but always in level areas.

The stone in the hilly areas contains as a rule a larger percentage of chert slabs and fragments from the bedded chert and a smaller percentage of the porous cellular gray chert.

Of these two soils—the silty post oak and the stony blackjack—the latter is the more productive. It stands drought better, warms up earlier in the spring, and does not become water soaked so readily during protracted wet weather. The silt soil with post-oak timber is often underlain with a stony layer that becomes cemented into an effective hardpan. This cuts off access to the red clay beneath with its supply of moisture. During extreme wet weather the hardpan layer seems to become softened and permits water to pass through it, but as it dries out it hardens.

Crops.—Up to the time of the building of the St. Louis & San Francisco Railroad through this area very little of either of these soils was cultivated. The bottom lands only had received attention up to that time. With the advent of the railway the country was widely advertised as a fruit-growing region. A great deal of land, principally the gray stony land, was cleared and set to orchards. So far as apples are concerned the result has not been satisfactory. The same statement can be made with regard to peaches also, except in a few localities. Apple trees grow fairly well, but they die soon after they are large enough to bear profitable crops unless they are well cared for. During the last 10 years there have been so many failures of the apple crop that the growers have neglected their orchards. They have not been cultivated. Brush has been allowed to grow up among the trees, they have not been protected from insect and other enemies, and the orchards have been pastured in many cases. The result is that they are in poor condition.

Peaches seem to succeed better than apples. In the southeastern portion of the area, around Koshkonong and to a somewhat less extent at other near-by places, peach growing has proved to be profitable. The orchards are kept in good condition and the country has an air of prosperity. Peaches do best on the gray stony soils with gray subsoils, the red clay not occurring for 3 feet or more beneath the surface. Along with the peach growing, cantaloupe growing is carried on successfully.

A great deal of attention has been devoted to grape growing at one locality, Brandsville, while farmers have a few vines throughout the region. At Brandsville the grapes are grown not for table grapes but for wine making. The vines, like peach trees, seem to do best on the gray stony blackjack lands.

THE HARTVILLE AREA.

Distribution and boundaries.—The Hartville area of Howell soils extends in a broad north and south belt from a short distance south of the State line northward to the Gasconade River hills south of the main line of the St. Louis & San Francisco Railroad in Wright County, Mo. The southern, western, and greater part of the eastern boundaries coincide with the respective boundaries of the belt. In general, the area includes the drainage basins of North Fork of White River and that of the Gasconade down to Arlington.

Topography.—The fundamental topographic feature of the area is, like practically the whole of the Ozark Dome, a nearly level plain. This is modified in two ways, faintly by the one, profoundly by the other. Its faint modification is effected by the occurrence on top of the general surface of the plain of occasional low hills. In one or two localities these occur so close together that they unite into a high

ridge. As a rule, however, they occur as isolated hills. Their area of occurrence lies in the south end of the belt, a few of them in Arkansas, but most of them in Ozark, Douglas, Howell, and Texas Counties in Missouri. The most northerly ones occur in Texas and Wright Counties. They occur mainly within the North Fork drainage area. The most northerly ones are lower, the higher ones being near the central part of their area of occurrence. The higher ones stand about 350 feet above the surface of the plain.

The plain has been profoundly modified by dissection. The streams draining it have cut a great many valleys into it varying in width and depth. South of the St. Louis & San Francisco Railroad the dissection is both deeper and more thorough than north of it. On the south side of the railway the valleys head as deep steep-sided ravines, and the whole country is cut up so thoroughly that practically no smooth areas occur in it. The ridges are narrow and slope to the streams draining them on each side. The main valley floors lie about 350 feet below the level of the plain. The general slope of the plain is southward at about the rate of the valley-bottom slopes. The depth of the valleys therefore remains about uniform southward. North of the St. Louis & San Francisco Railroad the plain has only an occasional knob belonging to the series so much more abundant south of the railway. Such as occur are low. This kind of interruption of the plain, therefore, is practically lacking. The area is dissected, however, but not so thoroughly nor so deeply as it is south of the railway. This is partly due to the drainage plan. An inspection of the map will show that the drainage lines south of the railway branch widely, somewhat like a tree, while north of the river the main streams run for long distances parallel to each other. Short side streams run into them from both sides, but they do not usually reach to the central line of the ridge from both sides. A long, narrow strip of country is left, therefore, between the main streams that is not thoroughly dissected. On each side of this lies a belt thoroughly dissected by the short tributary hollows. These ridge tops are still existing remnants of the plateau as it was before the main valleys and those of their short tributaries were cut.

The valleys are not cut so deep beneath the plain level as are those lying south of the railway. The streams are longer and take also a circuitous route to the sea. They are unable, therefore, to cut as deep into the same plain as do those south of the railway at points equally distant from their source.

The Hartville area therefore consists of a southern region of thoroughly dissected country, with widely branching drainage systems and a northern region of less thoroughly dissected country with more or less parallel main drainage lines and short tributary drainage.

The two regions will be described as the North Fork and the Gasconade regions, respectively.

The rocks.—It is unnecessary to describe in detail the rocks of this area. They do not differ to any important extent from those of the main part of the Westplains area. They are rather fine-grained, gray, moderately cherty, in the main finely crystalline limestones and magnesium limestones. They contain beds of the fine-grained, earthy, or "cotton rock" type, but the latter are of subordinate importance.

Soils of the North Fork region.—The predominant soil is a gray, stony silt loam. The subsoil is yellowish brown at top, becoming redder downward, finally becoming rather dark reddish brown. The rate of change with depth varies from place to place. The subsoil is not so stony, as a rule, as the soil. As a whole, this soil, so far as soil alone is concerned, is very much like the gravelly soil in the Westplains area. It is, in fact, the same soil, but occurs in a different topographic environment. It does not occur in basins and sinks. The general topography is rougher because of the more thorough dissection of the area. In the Westplains area the dissection is neither complete nor deep. In this area it is complete and deeper than in the Westplains area. The soils are more stony here, however, than in the Westplains area, and, probably as a consequence, post oak trees are more common and hickory less common than in the latter area.

This soil occupies the rolling ridges and the hill slopes, except the very stony, southerly ones. It occurs mainly in the northern part of the area. It extends southward as far as the vicinity of Buckhart and Noble in a nearly solid body, being broken only in the few flat areas on the ridges and in some saglike basins.

Crops.—Several years ago a good deal of attention was attracted to this soil on account of its being advertised as an important fruit soil. A considerable part of it was cleared and planted to apple and peach trees.

On account of the adverse climatic conditions that have existed during the last 8 or 10 years there have been enough failures to discourage the growers of both peaches and apples. The orchards have been neglected on this account, peach orchards suffering more than apple orchards. On the whole, fruit growing has not been as successful as was anticipated. The main difficulty has been the occurrence of spring frosts after the trees had blossomed out. The fruit grower may expect this and prepare to have his crop badly injured or totally destroyed about three years out of five unless he adopts means of avoiding their destructive effects.

The greater part of the area is devoted to the growing of general farm crops. The soil is rather hard to cultivate on account of the

stones in it, so that the yields are moderate. The yield of corn is 10 to 35 bushels per acre and of wheat about 6 to 10 bushels. Oats do not do well as a rule. Clover will grow reasonably well and without much nursing. Timothy does fairly well where the subsoil is not too stony. The soil is very low in humus as well as nitrogen and needs barnyard manure and more clover. It needs to be handled along with live stock in combined grain, grass, and live-stock farming.

Southward the proportion of large chert fragments in this soil increases and the thickness of the layer of disintegrated material decreases. In the latter respect the soil approaches and finally grades into the Berryville soils. There are all the stages of gradation between the thick soil layer, moderately stony or gravelly, predominantly red-oak land of the North Fork region, and the shallow soils or limestone "glades" of the Berryville areas. Areas of shallow, stony, gray, silty soils, with yellowish-red, silty clay, sometimes nearly stone-free subsoils sustaining a growth of small post oaks, occur in the southern part of the area, but they are small. Bodies of flat-lying gray silt lands occur, but are of wholly insignificant area, while blackjack soils are almost entirely absent.

In the covelike valley heads in the area of high hills in the Spring Creek country of Ozark County there are considerable tracts of soil essentially the same as the black gravelly clay soil of the Berryville group. They have received more or less wash from the small area of Springfield soils with which they are associated. These areas are all in cultivation and yield good crops of corn. There is practically no attempt to grow fruit in the southern part of this area.

Native trees.—The predominant tree is red oak. With it is associated some black oak, post oak, white oak, and hickory. The timber growth is vigorous, and the trees, though not yet mature, are tall and healthy. The average diameter 4 feet from the ground is not far from a foot.

Soils of the Gasconade region.—The Gasconade region of the Hartville area of Howell soils differs from the other areas already described, not so much in the different character of its soils as in the difference of topography and in the relative area of the different soils. In topography it lies intermediate between that of the Westplains and North Fork areas.

The stony to gravelly gray silt soil with reddish-brown subsoil, the predominant soil of the North Fork area and of the basin and undulating land of the Westplains area, occurs in this area also, but it is of relatively less importance in extent than in either of the preceding areas. It occurs both on the ridge tops where they are narrow and somewhat rolling and on the slopes. It is more common in the upper Gasconade country from the mouth of Beaver Creek southward to the railway, westward to the Osage Fork-Gasconade watershed and

eastward to the Beaver Creek-Roubidoux and Piney Fork watershed. Its area is triangular in shape, with the base on the railway and the apex at the mouth of Beaver Creek. The same soil occurs on most of the stony slopes in the rest of the Gasconade area, but does not occur so abundantly on the ridges. Its characteristics are essentially the same here as the North Fork and Westplains areas, except that the undulating ridge-top areas seem to be somewhat less stony. The trees are about the same in size and character of growth as in the North Fork area. Up to the time when the railway was built, about 1884, not much of this land had been cleared. Farms were confined mainly to the alluvial lands. At the present time large areas of it are still in timber and will remain so, because it is too stony to cultivate, but the gravelly portion is not especially difficult to cultivate and a considerable proportion of it is now in cultivation. It is mainly this land that is being cleared at the present time. It grows clover well, and fair crops of corn, wheat, and sorghum are produced.

The soil occupying the largest area in this part of the region is the equivalent of, or approximately like, the shallow, moderately stony gray to brown soil with nodular and brecciated chert, with the deep reddish-brown clay subsoil occurring in small areas in the Westplains area. In the Gasconade subdivision it has, as a rule, a somewhat thicker layer of soil material, but the nodular and brecciated chert is rather common, especially the former, and post-oak trees are numerous.

Its main area of occurrence is along the Roubidoux-Piney Fork watershed and along the slopes in the northern part of the area. It occurs also around the heads of Jacks Fork, Current River, and Piney Fork, extending eastward to within a few miles of Summersville and northward to Oscar, with small isolated areas along the ridge as far as Licking. It includes small pockets of black soil belonging in the Berryville group and grades off into the post-oak flats on one side and the gray gravelly to stony red-oak silt loam on the other. The gray gravelly to stony silt loam with yellow to yellowish-red subsoil, the typical soil of the smooth blackjack land, occurs in this area, mainly in its western part. Such areas partake more of the nature of tongues extending over from the Lebanon area of the Howell soils. They occur, however, well within this area, especially in the Elk Creek country. None of these areas, however, are entirely typical. They all contain a smaller amount of stone and a larger amount of silt in the soil than is found in the typical soil in the Lebanon area. They are transition phases between the true soils of this type and the post-oak flat soils.

On the northward slopes where they are smooth and not stony a phase of the gray gravelly black-oak soil occurs in which white oaks of large size are found. The soil is more argillaceous, has no hardpan, lies on the north slopes where evaporation is not excessive, so that it

is moist all season, and is well drained. It occurs mainly north of the latitude of Plato.

A large part of this area lies more than 15 miles from a railway station. The country is hilly and the roads stony. There is no possibility of growing truck or small-fruit crops, even if the soil were favorable all over the area. Bulky crops of any sort are practically ruled out by this lack of transportation facilities. Even grain can not be hauled to market economically from a large part of the area. The only system of farming that has ever been profitable is live-stock farming, and that at that early time when the unoccupied land was covered with a good growth of native wild grass. The more fertile land was utilized for growing winter feed, and the stock ranged on the poorer upland soils during the grazing season. On account of the growth of brush and timber the range grass has been killed out. The pasture thus destroyed has never been replaced by tame-grass pastures. The more fertile lands, the alluvial lands and a small part of the upland, never has grown enough feed to keep all the stock throughout the year or even to fatten it for the market during the winter. Grain-fed stock never has been sold out of this area to any extent. It was sold off the range during the summer, and feed was grown solely for the purpose of keeping the stock over the winter. When the outside range was destroyed the grain-growing capacity of the country was not increased—at least not enough to balance the loss of the range. Stock raising had to be curtailed therefore. This reduced the income of the area by the amount of the curtailment, for it has never been balanced by an improvement in the quality of the stock. Live-stock farming in some form adjusted to the new conditions, however, is the only kind of farming to which this area, as well as most of the other areas of the Howell soils, is adapted at the present time. This limitation is placed upon the country not entirely by its soils, but mainly by its topography and its transportation facilities. There is no evidence that the latter condition will change soon, and the former will never change. The industry of the area must continue to be stock raising. This can be effected on the old scale only by getting the range back again. To do this it will be necessary to clear the land of brush and timber and allow the old native grass to reset itself or else to substitute tame grasses adapted to the soils, such as orchard grass and clovers, with alfalfa on the creek bottom lands. The soil will not grow enough grass to support one steer or cow to the acre. Several acres will be required for each animal, at least for several years to come. This makes large farms necessary. It is not a country where the small farm can be made profitable. One hundred and sixty acres seems to be the minimum, and twice that would be better. The land will have to be bought at a low price and a considerable amount of capital

invested in it over and above the purchase price. It is not a region where the 40-acre farmer, with only capital enough to buy his land but with none for improving it, can make more than a very poor living—merely a bare existence.

The Lebanon Area.

Distribution.—The Lebanon area of Howell soils lies north and west of the Gasconade area. Its eastern boundary lies approximately along the watershed between the Osage Fork and the Gasconade from near the mid-point on the east line of Webster County, Mo., down to the vicinity of Delto, where it crosses to the west side of the Osage Fork; thence north and east it follows approximately the western and northern boundary of the intricately dissected belt of country on the west side of the Osage Fork and the west and north side of the Gasconade below the junction with the Osage Fork. It extends eastward to the Gasconade "breaks," to where the Hartville soil belt is broken by the Gasconade Valley. Its northern and western boundaries are coincident with the group boundaries.

Topography.—The predominant topographic feature is a smooth plain. In its central part it is nearly flat, with very gentle undulations. Around its borders it is dissected. It is a part of the plateau top, an area of the old smooth plain surface that once extended over the whole Ozark Dome. It has continued to exist in its old simplicity of surface form because it has lain in an out-of-the-way position with respect to drainage lines. It has not been dissected simply because dissecting streams have not yet worked their way back into it. They are continually nibbling at it around its edge and will eventually reach its center. Until then it will remain smooth. It is surrounded by a border belt of country at one time a part and parcel of it and like it in all essential respects. Dissecting ravines and creeks have cut the surface to pieces, making a border of rough, hilly country. The hilly border extends along the eastern and northern sides, and belts of it reach up into the plain along the larger streams. Along the west side, however, it merges rather imperceptibly into the smooth prairies, with tongues of hilly Lebanon soils extending into them along the streams.

The smooth plain of the Lebanon area lies in Laclede and Webster Counties, the St. Louis & San Francisco Railroad running along its eastern side.

In addition to the plain and its dissected fringe, there is in the northeastern part of the area another type of topography, not a dominant or even a very important one in point of area over which it extends, but characteristic nevertheless. This consists of a series of watershed ridges, usually narrow, but occasionally expanding into broader areas. They stand on a lower plain, which is covered with the

Iberia soils. These ridges separate the belts of Iberia soils from one another. The trend of the ridges across the country is determined, therefore, by the trend of the watersheds, and the ridge tops lie in the same plane with the upper surface of the Lebanon Plateau. They are not intricately dissected, but the headwaters of small streams rise in covelike valleys opened into the ridge sides. They occur in most perfect development and most abundantly in Miller, Maries, and northern Pulaski Counties. They are the product of a more advanced stage of dissection than that existing in the plateau fringe. They are remnants of the plateau reduced to the lowest terms consistent with existence. The next lower term will be extinction. The smooth plain and these ridges represent the approximate extremes of topographic development, the one the infantile stage, the other the extreme old-age stage. Neither phase exists in exactly this form to any important extent in either of the other areas of Hartville soils.

The rocks.—The rocks are essentially the same as those existing in the other Hartville areas already described. The description does not need repetition.

Native trees.—The predominant trees within the Lebanon area are blackjack and post oaks. Other oaks occur and predominate in certain localities and for small areas, but the two first mentioned are the ones that predominate by far. They occur in the same areas to a certain extent, but in a broad way each has its area of occurrence where it constitutes the dominant feature of the tree growth.

The blackjack is the characteristic tree of the Lebanon plain. Over a large part of it this species is practically the exclusive tree. On flat areas patches of post oak occur, and the same tree occurs with the blackjack in other areas. Hickory is associated with the predominant tree in some places, while black oak occurs in others. On the watershed ridges of the northern part of the area post oak is the characteristic tree. It does not usually constitute as much as half the tree growth, but it is usually more abundant than any other species. Its occurrence is a function of the thickness of the layer of soil material. If that be thin—less than 2 feet—the trees will be mainly post oaks. If thick, and the land well drained, black oak and red oak will occupy the northward slopes and less stony areas and blackjack the south slopes and the very stony areas.

In the hill belt along the northern and eastern sides of the Lebanon plain and along the creeks elsewhere in the area the tree growth consists of red, black, and post oaks and blackjack, growing in association in some areas and more or less segregated in others, depending upon the topography and soil.

The soils.—There are two soil types occurring on the Lebanon plateau. The predominant type is a gray to dark-gray, occasionally dark-brown, silt loam. On the steeper slopes, and in isolated spots

here and there, it is stony, the stone consisting of rather large, rough slabs of chert or flint. The subsoil is a gray to yellow clay in its upper part, changing downward to a rather dark reddish brown gravelly to stony clay. A tinge of yellow usually remains in the soil down to a considerable depth, often to a depth of more than 3 feet.

This is the soil on which the blackjack timber grows. Up to about 30 or 40 years ago this area was practically treeless. Sumac and hazel were rather widely distributed over it, especially on the better-drained portion. The blackjack timber has since that time grown up and smothered out most of the sumac and hazel. There is a small percentage of post oak, black oak, and hickory mixed with the blackjack.

The other soil of the plateau is a gray silt to silty clay with a subsoil much like that of the gravelly land. Occasionally it contains a considerable percentage of flint blocks, usually 6 inches to a foot or more in diameter. It does not occur in large unbroken areas, but rather in patches or pockets of a few acres or even of less than an acre. The subsoil is a silty clay with a substratum of stony red clay sometimes lying within the 3-foot section. Small, poorly drained areas occur in this soil. This is the post-oak land. The trees are, as a rule, small, but occasional large trees occur, relics of a time when they were the only trees in their vicinity. This soil does not differ essentially from the gray stone-free silt of the Westplains area.

The gravelly soil of the Lebanon plateau, however, differs from the black-jack soil in the Howell area in being less stony and containing more red in the color of the subsoil. It is a stronger soil and more easily cultivated on account of the smaller percentage of stone. It is not a strong grain soil—one that can stand continuous grain cropping for several years—but its physical character is good and with care it will grow clover. It is not as good a clover soil as the hill-land soils with black and red oak timber and brownish-red rather than yellowish-red subsoil. Clover will grow, however, if some care is exercised by the farmer. With the production of clover and a system of live-stock farming with pasture in the rotation, the fertility can not only be kept up, but it can be raised above what it has ever been.

This soil has attracted considerable attention during the last few years as a fruit soil. A great many apple trees have been set out on it and some large orchards have been planted. They have not been very profitable. The trees do well, but the climate is not favorable, owing to late spring frosts, which have occurred very frequently during the last decade. It is now certain that fruit farming in this region on a large scale as an exclusive business

can be made profitable through a long period of years only by the adoption of some means of avoiding the effect of these frosts.

The gray silt lands are rather well adapted to timothy and redtop. The soil of the watershed ridges of Miller County and counties adjacent is a stony gray to brown, yellowish-brown, or reddish-brown clay and silty clay, with usually shallow dark reddish-brown clay subsoils. The layer of soil material is usually thin. The subsoil is not so stony as the soil. It is the same soil as that occurring around the eastern border of the Westplains area—the hill border.

Agriculturally this soil is not of great importance. Most of the area in which it occurs is still in timber. Patches of the gravelly soils of the plateau occur in it, as well as of the dark-gray hill-land soil with red-oak timber.

The tree growth is mainly post oak. This soil occurs typically on the tops and southward slopes of these ridges. On northward slopes the layer of soil material is often thicker, and where such is the case the soil type changes. In the hill belt along the eastern and northern sides of the plateau and along the larger streams within it the plateau soils and water-ridge soils occur, the latter more often than the former. In addition, there are occurrences of soils practically identical with the gray stony hill-land soils, with moderately stony, reddish-brown subsoils occurring in the North Fork area. They lie in small areas here and there, the determining factors of their occurrence being the topography and the thickness of the layer of soil material.

In the dissected rim belt of the Lebanon plateau the soils are in part like those in the North Fork region and in part like the shallow stony post-oak soils. As a rule, the timber growth on the former soil is not so vigorous, or at least not so large, as in the North Fork or the southern part of the Gasconade region. There is a smaller proportion of the total area covered with this soil than in the other areas.

THE ROLLA AREA.

Distribution.—The Rolla area of Howell soils includes all those areas of the series lying east of the Gasconade River and north of the Clarksville soils area. It is bounded on the south by the Clarksville soils, on the west by the bench-land soils described in this report as the Iberia group, and on the north and east by the main area of the Union soils.

Topography.—The topography is unlike that of the main body of any of the other areas. That of the whole area in which the Rolla phase occurs is a dissected plain sloping gently northward. The southern boundary of the area is the southern boundary of the northwardly sloping plain.

South of this boundary, in the area of Clarksville soils, the dissection is thorough, sharp, and deep. North of it it is shallow, incomplete, and more or less rounded, giving a softer profile than in the southern area.

This is a transition area in which the Howell soil-farming material is descending beneath material forming other soils. The latter occur on the ridge tops practically throughout the whole area, confining the Howell soils to the slopes and rolling areas lying below the ridge-top level.

The valleys along the southern border of the area are mere upland swales or dry, saglike valleys. They deepen gradually northward, but even along the Bourbeuse River, into which the streams all flow, the valleys are rarely more than 200 feet deep and usually less than that. As a whole, therefore, it is a region of shallow dissection.

A striking feature of the Bourbeuse tributaries is their intricately winding valleys. The Bourbeuse itself has a most extravagantly winding course, increasing its length between the mouth of Dry Fork and Union from 25½ miles, the course by direct line, to 77 miles, almost exactly three times this distance. Its tributaries have similarly crooked courses. The principal economic results of this characteristic are the lengthening of the valleys and the consequent increase in the length of the alluvial belt and the shallow dissection resulting from the inability of the large streams to cut deep valleys because of their long courses. The relatively faint relief and the large amount of river bottom are the distinguishing features of the topography of this area.

The rocks.—The rocks differ very little from those of the other areas. They consist of the same series of crystalline and earthy limestones, but the chert content is not so great as it is in the other areas.

Native trees.—The native timber growth consists of mixed oaks, with red oak and white oak occupying a more important position than in either the Lebanon or Westplains areas. On the ridges where they are not covered by soil of some other series there are many patches with blackjack timber. Post oak occurs in patches of clay soil and mixed with the other timber.

The soils.—The dominant soil type is a gravelly gray silt loam with a reddish-brown subsoil, though the gray color may extend to a depth of 2 or 3 feet occasionally. It is essentially the same soil as the basin type in the Westplains area and the gray stony soil with red oak in the North Fork area. It is the type that supports the growth of mixed oaks. Along the Bourbeuse it is usually less stony than farther south. On the northward slopes it becomes sufficiently stone free and argillaceous to support a growth of large white oaks.

It includes small areas also of gray silt loam free from stone, with pale brownish subsoil, occasionally bluish clay or silty clay, usually stone free. It supports a growth of laurel oak, hickory, wild cherry, white oak, ash, and an occasional walnut and elm tree.

Associated with this soil there are occurrences of the gravelly soil of the Lebanon Plateau. These usually occur on the ridge tops and on southward slopes and are more common in the southern part of the area than in the northern. These areas change imperceptibly into areas of gray silt, the stone content decreasing with the smoothness of the topography and the increase in the thickness of the surface silt layer. Such areas are covered with post oak chiefly and more closely allied to the post-oak flats with Lebanon soils than to the Hartville soils. They are usually underlain by a stone layer varying in depth, but rarely amounting to 3 feet. It may or may not be cemented into a hardpan, but very often is. This in its turn changes into the gray silt loam described in this report as Owensville. This ranges from the unchanged Owensville to the unmodified gravelly blackjack soil of the Lebanon Plateau and covers the stages of erosion of the silt layer from where it has its maximum thickness to where it has disappeared entirely.

Very little of the soil occurring on the watershed ridges of Miller County is found in this area. It occurs on south slopes here and there, but is not of much economic importance.

A larger proportion of the upland soils of this area is under cultivation than in the dissected portions of either of the other areas. This is due to the smaller percentage of stone in the soil, the less pronounced topography, and the better transportation facilities furnished by the St. Louis & San Francisco Railroad, which runs through it. The cultivated land is better cultivated, the farmers are more prosperous, and the farms are better equipped, taking the region as a whole, mainly because it is occupied to a very great extent by German farmers. While they do not open up new land rapidly, they care for what has already been opened up. There is very little abandoned land within this area.

Crops.—The Germans are general farmers, followers of a cropping system that makes grain growing the most important factor of the system and live stock a subordinate factor. In this area they are not exceptional in this respect, save that poultry raising is an important part of the system, though no attempt is made to make it the main or only feature. They are not given to fads in farming.

Along the railway some attention has been paid to apple growing, with only fair results. The crop suffers from cold weather in the spring about as much here as anywhere else in the region. The gravelly land, either that like the gravelly Lebanon Plateau land or that like the stony to gravelly land of the Westplains area, is well adapted

to small fruits. The most important suggestion that can be made regarding the modification of the existing system is that more attention be given to live-stock raising and, where transportation is convenient, to dairying. Live-stock raising, poultry raising, and small fruits on the gravelly soils, apples in a small way, and grain growing are the lines suggested by the soil, topography, climate, economic conditions, and people.

Berryville Soils.

Distribution.—The soils included in this group occur in the upper White River Basin in southwestern Missouri and adjacent portions of Arkansas, mainly in Baxter, Marion, and Carroll Counties in Arkansas, and in Barry, Stone, Taney, Ozark, and Christian Counties in Missouri. Except in the southwestern part of this area the series does not occur in large areas, but in a great number of small areas. These may be located by referring to the accompanying soil map.

The soils.—The area includes a considerable range of soils, when their characteristics are considered in detail. They are common in being rather shallow and in being derived from a limestone that ranges in character from shaly to rather thin-bedded rock, most of it being earthy or argillaceous, soft, and not well crystallized. It is only moderately flinty, and the shaly and very thinly bedded portion is entirely flint-free.

The soil ranges from nearly white through reddish brown to black, and from stone-free to moderately stony. The subsoil ranges from gray, yellow, and greenish yellow to deep reddish brown. All over the areas where these soils occur the limestone beds are frequently exposed. There are considerable areas of "glades" and they occur in all parts of the area. This is the area in which occur the "balds" that are so conspicuous a feature in the White River Basin and somewhat less so in that of the Osage and Gasconade. In the White River Basin, especially in the vicinity of the river valley, there are many prominent conical hills that have received such names as Bald Jesse, Naked Joe, and Griffiths Knob, all suggestive of their character.

These soils occur mainly in the southwest central part of the Ozark Dome, not as a continuous area, but in several more or less isolated areas. These are: (1) the Middle White River area, (2) the Berryville area, (3) the Jenkins area, (4) the Mountain Grove area, and (5) the outlying areas.

The Middle White River Area.

Distribution.—This includes the area in the vicinities of Mountain Home, Yellville, and Lead Hill in Arkansas and small areas extending from these across the State line in Missouri. The three towns

named lie approximately in the central part of each area. They are merely different parts of one area separated by White River or belts of high land. They vary slightly in character of soil and rock. The former two areas are alike in most respects and are separated only by White River.

The Mountain Home country.—The Mountain Home "barrens" in Baxter County, Ark., is a high ridge-top upland with an undulating to rolling surface. The valleys of the streams draining it are shallow, deepening southward, but not more than 125 feet deep as a maximum. The stream heads are mere sags in the upland surface, sometimes poorly drained. Occasional rather sharp hills stand on this plain, rising from 50 to 250 feet above it. These increase in number southward and finally unite into a continuous area of higher country. The "barrens" area therefore slopes gently southward. Eastward it breaks off into the flinty North Fork hills, some of which area is included in this series, and westward into the White River hills. Northward the country rises, but soon changes to a flinty, stony region.

The rocks.—In the Mountain Home barrens, as well as in the Yellville area in Marion County, there are three series of rocks that belong in the group, while a third has had some effect locally in modifying the soil. There is an upper series of subcrystalline and earthy, fine-grained gray flinty magnesian limestones, a middle series of alternating, thin-bedded limestone and yellowish to greenish calcareous shales, all being nearly free of flint, and a lower series of rock much like the upper, but containing somewhat more flint and occurring ordinarily in more massive beds. The limestone also is somewhat more crystalline and grayer in color.

The two lower formations are the ones from which most of the soils have been derived. The upper one occurs only in the hills that stand above the general level of the "barrens."

Native trees.—The most abundant tree in the area of this series is post oak. It occurs on all the soil types, but is the typical tree on the "glades," the shallow soils, and the gray soils with moderate to poor drainage. Along with the post oak occurs blackjack. Red oak is found on the redder lands.

The soils.—The soils of the Mountain Home area are all relatively shallow. The bed rock is rarely more than 4 or 5 feet below the surface, except where there has been a local accumulation of soil. The soils are gray to brown silts and silty clays. The subsoils are gray, brown, reddish brown, or greenish yellow, depending upon the drainage and the formation. Where they are derived from the shales they are gray if poorly drained and greenish yellow to brownish where they are well drained. Where derived from the more crystalline limestones they have a stronger color.

The soil from the flint-free limestones, where the soil layer is thin and where it is kept moist during a large part of the year by seepage water from the bedrock, has a very dark brown, sometimes black color, and what subsoil it has is reddish brown. Such occurrences are usually in gravelly sags and small valleys where the wash has accumulated and in pockets on glady slopes.

In the broad valley sags, where they lie in the shale series, the soils are gray to dark gray and often poorly drained. Associated with these broad upland sags, there are areas of dark-gray to brown gravelly soils with reddish-brown subsoils occurring in small mounds, 2 to 5 feet high, often thick enough to occupy the surface, except for very small low places among them. The bedrock is often exposed between the mounds. They are overgrown by small post oaks that have sprung up within the last 30 or 40 years. Up to that time all these areas were treeless.

There are considerable areas of smooth gray silt land underlain within a foot or so by massive chert, or else the chert is broken up into large blocks and lies in the soil. Such areas are usually poorly drained.

There is a large area of moderately cherty gray land, with a brown to deep brownish red subsoil, locally too cherty for easy cultivation, but usually tillable.

The gray silt and clay lands, derived largely from the shale, occur mainly in the southern part of the area. A considerable area lies in the vicinity of Buford and between Buford and Gassville, as well as around the latter place. They occur also in the heads of all the streams rising around Mountain Home. Each of these originates in broad wide open basins containing these soils.

The glady land lies on the steeper slopes throughout the area, but it is not, as a rule, covered with cedar. The moderately stony land occurs on the uplands, well scattered over the area.

The Yellville country.—The soils of the Yellville area do not differ essentially from those of the Mountain Home area. The topography, however, is rougher. The area is a basin also, or rather it is a covelike section lying in the southwestern part of the general area. Being rougher, a large proportion of it consists of "glade" land and a smaller one of the gray silt land. The shales occur, but they outcrop on slopes and their soils are removed by erosion. A larger proportion of the soils lie on the rolling land and are therefore not leached to the extent that some of the Mountain Home soils are. They are also better drained and therefore somewhat stronger. The glades are, in much of the area, covered with cedar trees. In other respects the soil and topography do not differ from the Mountain Home area.

The Lead Hill country.—The Lead Hill area is separated from the Yellville area by a tongue of high land carrying other soils. It is a basin, like the Yellville area, opening northward, but inclosed by high land south, west, and east.

The rocks.—The rocks occurring in it are the magnesian limestones, to a considerable extent chert free. There does not seem to be the sharp differentiation into three series of rocks as in the other areas, but the time spent in the basin was not sufficient to determine this matter with certainty. The shales were not seen, though soft, thin-bedded earthy limestones occur abundantly, as well as cherty limestones. The chert, however, seems to exist in rather well-defined beds, some of them more than a foot thick. Massive, crystalline, dark-gray limestones are found also. On account of their resistance to erosion, they usually outcrop in exposed ledges along the slopes. They weather into rugged, pitted surfaces.

The soils.—The most abundant soils in the basin are the gray, somewhat stony silt soils with gravelly to stony brown to brownish-red subsoils, the latter color predominating; the dark to black flint-free "glade" soils containing abundant limestone fragments and the gravelly gray but shallow basin lands growing native post oak—a seepy land, owing to its shallow soil and the fact that during wet weather water is continually oozing from the underlying limestone. In dry weather, on the other hand, it dries out rapidly. It is an intermediate phase between the two soils with which it is associated.

This character of country extends northward across the State line into Taney and Ozark Counties, Mo., the soil gradually becoming more cherty, the layer of soil material thicker and less interrupted with "glades," and grayer in color, finally grading into a soil group designated in this report as the Howell soils. The Berryville soil-forming rocks rise in this direction and the creek valleys are eroded deep into the underlying Howell rocks, so that the Berryville soils occur as strips on the ridge tops and upper slopes, narrowing northward, and finally fading out northwestward, where they terminate abruptly against the Springfield soils.

The topography of the southern end of the basin from a mile or so south of White River southward is rolling. North of that it is very rough, practically too rough for cultivation except in small patches. A small area of country around Kirbyville is topographically much like the smooth southern end of the Lead Hill area, and north of Forsyth, in the Bull-Swan-Beaver Creek country, the topography is rough, but considerable areas are not too rough for cultivation.

THE BERRYVILLE AREA.

Location and topography.—The Berryville area lies in Carroll County, Ark., and Barry, Stone, and Taney Counties, Mo. White

River has cut a narrow winding valley into this region from 250 to 400 feet deep, and a narrow belt on both sides of it is thoroughly and deeply cut to pieces and entirely too rough to allow the cultivation of any considerable part of it. The whole width of the belt between Branson and Baxter, Mo., is of this nature. It is the typical "bald" region. The soil covering is so thin on considerable areas of it that the rock ledges can be followed in their outcrops around the hills from long distances away. The soil layer is in such cases too thin to support trees. Above Baxter, however, the belt widens, opening southward into the broad Berryville basin and northward into the smaller Shell Knob basin.

Considering both areas as one, it also is a basin and much more nearly inclosed than the Lead Hill area. It is open to the eastward down White River and northward up James River, in the former case into the great upland of the southwestern Ozarks, in the other to the small Jenkins area of the same soil group. White River and Kings River have both cut deep, narrow, winding valleys into the surface of the basin.

A larger proportion of the Berryville portion of this area is in cultivation than is the case in even the southern part of the Lead Hill basin. Except very narrow belts along White River and the larger creeks of the area, the greater part of it is in cultivation, producing fair to good crops of corn and wheat. Its smooth topography and comparatively high state of cultivation are in sharp contrast with the extremely rugged and almost wholly uncultivated border lands of the Springfield soils which surround it. It attracted the early pioneers, and has been a kind of agricultural oasis in a desert of forest for nearly three-quarters of a century.

The greater part of the area contains the same soils that occur in the Lead Hill area. There is another phase of soil here, however, occurring in areas large enough to be of importance in the agricultural production of the region, that occurs in the other areas only in very small patches. This is a stone-free brown silt loam with a deep reddish-brown clay or silty clay subsoil. It is the most productive soil of the series. Its native trees were red oak, white oak, walnut, elm, and wild cherry, with occasional post oaks. This soil occurs chiefly in the southern part of the area, in the vicinity of Berryville, Ark.

THE JENKINS AREA.

Location, topography, and soil.—The Jenkins area lies in the northeastern part of Barry County, Mo. Like the Berryville area, it is a basin, being more completely inclosed, however, since it is open only to the eastward down Flat Creek. Its upland surface is about as high above sea level as is the Berryville basin, but its streams are smaller and unable therefore to cut such deep valleys into it. Its

upland areas are as smooth as those of the other basins, while its creek hill belts are smoother. A larger proportion of its area is capable of cultivation than is that of the other basins. Its soils, native timber, and general appearance are the same.

THE MOUNTAIN GROVE AREA.

In the southwestern corner of Texas County and the southeastern corner of Wright County lies a small area of these soils separated from the main Baxter area by a wide space of other soils. It lies on the top of the Ozark Dome at an elevation of about 1,500 feet above sea level.

Topography.—The area consists of a small stretch of country with a string of knobs along the southern side dropping off steeply on the south side of these knobs into the heads of the North Fork drainage. North of them there is a belt of smooth but not flat country with northward drainage. The valleys for 4 or 5 miles from their heads are shallow, at first mere open sags, farther down shallow, flat-bottomed troughs. They do not become deep enough to make rough country in less than 4 miles from the string of knobs at their heads.

The rocks.—The rocks consist of an upper series of nearly chert-free thin-bedded—often approaching a shaly structure—soft, earthy limestones and magnesian limestones, and a lower series of somewhat heavier bedded limestone, more crystalline, and containing more chert.

Native trees.—The knobs are either bare of trees or support a growth of stunted post oaks, except where the knob is capped with a layer of Clarksville soil, as is the case with one or two of them. In these cases there is a growth of young red oaks and black oaks.

The soils.—The soils are shallow, except when there has been a local accumulation, such as has taken place in the heads of the valleys. They are all silts with silty clay subsoils. They are gray in color as a rule, darkish gray in moist places, and brownish red where somewhat eroded or occasionally where there has been local accumulation. The predominant color is gray. The subsoil is gray in the seepy places on account of poor drainage and brownish to reddish brown where the drainage is good. The knobs, except the ones capped with Clarksville soil, are glades on the slopes, especially the southward slopes, with a thin cap of gray silt at top supporting post oak saplings, with occasionally a clump of persimmon brush.

Aside from the glades and silt caps on the knobs there are two kinds of soil—the flint-free gray to dark-gray silt with silty clay subsoil, often wettish, in which case it is typical gray crawfish land, and a gray to brown gravelly to stony soil with a brown to reddish-brown subsoil. The latter is yellowish to yellowish brown on the

dry gravelly black-jack ridges. This soil is intermediate in character between the stone-free silt soil described above and the stony soils of the Hartville area. It occurs principally in ridges and upland flats or gently undulating areas, sometimes with a thin layer of silt on top but a stony subsoil. Where the land is undulating, well drained, and only moderately stony it is covered with a growth of red oak and is when cleared a fairly productive soil. On the drier ridges and on the flats where the stone layer is only a few inches below the surface the native tree growth is black-jack oak and the soil is not so productive. In some cases the stone layer is cemented into hardpan.

A few years ago this region was planted to orchards rather extensively. While fruit growing has not proved to be entirely unprofitable, the growers have not met with the success that was anticipated. Fruit trees will not do well on the stony dry soils of the region on which black-jack oak was the native forest tree. Neither will they do well on the poorly-drained gray silt and silty clay lands. They will grow, however, and do well, when properly cared for, on the red-oak lands and the well-drained, gray to brownish stone-free soils with brownish subsoils.

In recent years many of the farmers have taken up dairying in a small way. This is not the place to discuss this question in detail, but it may be stated that the industry fits the natural and social conditions now existing in the region so well that with reasonable care, foresight, and work it could hardly fail to be successful.

The Ava area.—The county seat of Douglas County, Mo., is situated in an open basin with gently sloping sides, lying about 100 feet below the adjacent hilltops. It contains a gray, dark-gray to black silty clay soil with grayish to brownish subsoil, both nearly stone-free. It corresponds essentially to the stone-free Berryville soil, or Berryville silt loam. There is only a small area of it, probably about a square mile.

THE OUTLYING AREAS.

On the extreme south line of the State of Missouri, in McDonald County, there are two or three small areas of these soils, all occuring in inclosed basins and all having characters that distinguish them sharply from the surrounding country. The only one of these basins, however, large enough to be shown on the map is called White Rock Prairie, and lies 5 miles southeast of Pineville, the county seat. This is larger and has a surface and soil that is typical. Its exposed ledges of white or gray limestone, which make it so conspicuous a feature, suggested the first part of the name, and its lack of tree growth, due to the shallowness of its layer of soil, suggested the rest.

GENERAL CONDITIONS IN BERRYVILLE SOILS.

This whole belt of country extending from the hills of North Fork of White River westward along that stream, at first as a continuous area, farther westward in broken areas, is a country with pronounced individuality. Its topography, rocks, soils, native vegetation, farms, farm buildings, and to a certain extent its people, are characteristic and possess an individuality not found elsewhere in the Ozark country.

The western basins and areas, as well as those parts of the eastern areas lying in the State of Missouri, are mostly cleared, and all the cleared land is in cultivation. This is far from the state of affairs in the Yellville and Mountain Home areas, however. In the latter area particularly nearly half the land that was cultivated at one time is now either abandoned entirely or practically so. The farm house on some of these farms is occupied, but in too many cases it is by old people who are able to do no more than cultivate indifferently a small garden. The rest is left to grow up in weeds and brush, the fences and barns either tumble down or are burned by the spread of autumn woods fires. In other cases not even this much is being done toward cultivation. In other cases where there is an attempt to cultivate the farm it is done in a half-hearted way.

The Yellville area has considerable land in the same condition, not so large a proportion of its whole area, however, as in the Mountain Home area. The Lead Hill area has a still smaller proportion of abandoned land, though its occurrence is frequent enough to be noticeable.

Various causes are assigned for this state of affairs. Whatever the true cause may be, however, it can not be ascribed entirely to the character of the soil of the particular area. The Berryville Basin has the same soil, yet it is not only not abandoned, but is carefully cultivated, and additional new land is being put into cultivation.

There are two main causes for the abandonment, and probably several subsidiary ones. One of these is the mining agitation of a decade ago, which caused the wholesale purchase of large areas of farm land by nonresidents solely for the purpose of speculation. These people were not farmers; they did not buy the land with the intention of cultivating it or of having it cultivated. The land also is not profitable and can not be made immediately profitable as farm land operated by tenants. It is not fertile enough; it will not stand abuse and continue to yield profitable crops. The owners are unwilling to place it in condition for cultivation, and it is therefore abandoned.

The other main cause assigned, and undoubtedly it is an important one, not only in this particular region, but in the whole Ozark region, is the recent active advertisements of western lands, including Oklahoma, the High Plains region, and the irrigated basins of the far

West. This has caused a great many former occupants of the Berryville soils to abandon their farms and seek new and more fertile land in those regions.

Both these causes have about spent their force. Little or no land is being bought up as mining land at the present time. There is still some movement toward the far West, but the rate is less than it was a few years ago.

In order to revive the agriculture of the region there must be an influx of new population with new aims and ideals. That still remaining of the old population is somewhat demoralized; it is disheartened; there is a spirit of discontent or of stoical resignation and acquiescence to be found everywhere. The matter can not be solved by bringing into the region settlers from the prairies of Illinois, Iowa, northern Missouri, or Kansas. This has been attempted in many Ozark localities already, but has never been a success. The conditions are wholly unlike those with which such people have been familiar. They can not satisfactorily adjust themselves to so great a change. The difficulty does not lie so much with the farmer himself as with his wife and children; they will suffer most in the attempted transplantation.

The area must be reclaimed by hill-bred men—men from the driftless area of southwestern Wisconsin and adjacent portions of Iowa and Illinois, the upper Ohio region, the hill regions of the southern Appalachians, or the hill areas of Norway, Sweden, and Germany.

In one respect these farmers operating on the alluvial lands of the smaller streams of this soil series, especially in the Yellville and Lead Hill basins, are more progressive than those on many of the other Ozarkian soils. Many of them have become successful alfalfa growers. This is true more particularly of farmers operating on the bottom lands along the small streams of these basins whose heads lie back in the surrounding hills. It is particularly well developed along Crooked Creek in the Yellville basin and Sugarloaf Creek in the Lead Hill basin.

The Mountain Home area has not developed alfalfa growing partly because it is mainly on the upland and has practically no alluvial land. The alluvium of the larger streams has not yet been devoted to any important extent to the growing of alfalfa. The valleys are narrow and are often considerably more sandy than are the valleys of the smaller streams.

The northwestern boundary of profitable cotton growing lies across this belt or series of areas. It is grown in White River Valley to the south line of Taney County, Mo., and occasionally a little higher. On the uplands it is grown in a small way on the gravelly and stony lands over the eastern areas. It is not grown in the Berryville, Jenkins, or McDonald County basins.

Aside from these two special crops the agriculture of the area, so far as crops are concerned, does not differ from that of the more northerly portions of the Ozark Dome. It is a region of grain and subordinate hay farming with subsidiary stock raising. The latter is somewhat more important than in the region as a whole, since the wild grass on the hills surrounding the basins has not yet been entirely killed out. Within the basins also, especially on the glady lands, there is still a rather good growth of grass.

In the extension of the stock-raising industry, particularly of sheep and cattle, along with the growing of alfalfa and grain, lies the prosperity of the region in the immediate future. This was the system of farming, excepting the alfalfa, adopted by the early settlers because it corresponded with the natural adaptabilities of the region. That was the simplest and shortest way of adjusting man to his environment in the region. The growth of brush has temporarily disturbed this adjustment, but until the social and economic conditions enable the region to engage in some form of intensified agriculture, this is the adjustment dictated by nature, and man will have to submit.

Izard Soils.

Distribution.—The Izard soils lie in Arkansas. Izard County contains the largest area, but they occur also in Sharp, Independence, Fulton, Baxter, Stone, and Marion Counties. North of Baxter County they occur in Ozark County, Mo., in small patches of a few acres in extent in the rough region known as the Spring Creek Hills, but they are not tillable.

The rocks.—The rocks from which these soils are derived are sandstones, calcareous sandstones, and sandy limestones. The total thickness amounts to several hundred feet as a maximum, but this occurs only in the central part of the area. Eastward, westward, and apparently northward from this the rocks thin out and finally disappear. Where best developed the series consists of an upper member of several hundred feet of sandy but nearly flint-free limestones and limy sandstones and a lower member of massive sandstone. The sandstones are white, gray to light brown, coarse-grained quartzose sandstones, with well-rounded grains and a relatively small amount of argillaceous matter. The limy beds are predominantly medium to finely crystalline gray to bluish-gray massive to thin-bedded but hard rocks. The sand usually occurs in them as thin laminæ and thin lenses It varies in amount, but will range probably from 25 to 40 per cent of the rock mass.

The whole series of rocks forms a soil varying in percentage of sand from a negligible quantity to a pure sand. Over the area as a whole, except the extreme northern border, the soil is predominantly a sandy

loam or fine sandy loam. The subsoil is heavier, being in most cases a andy silty clay.

Topography.—As a whole the topography is strongly rolling. Along the creeks, however, it is so thoroughly cut to pieces that there is no level land left, except occasional small patches of a few acres in extent.

In the western part of Marion County, Ark., these soils occur only in narrow strips along the hillsides or in narrow hollows and are too rough to be tilled. From the meridian of Yellville eastward, however, they occur on areas that lie below the level of the hilltops but on undulating, rolling, and moderately hilly land, rather than on the hillsides. Here much of the area is tillable.

Native trees.—The most common trees are red oak, black oak, and pine. White oak occurs locally, so also does post oak. Blackjack is found also on the drier, more nearly level sandy soils. The trees on the rolling land have a healthy appearance and make a vigorous and rapid growth. Chinquapin groves occur locally, usually in places where the soil is especially light colored. Such land is usually considered the least valuable of all the sandstone types.

The soils.—The soil is gray to yellowish gray, becoming pale yellowish a few inches beneath the surface. The subsoil is yellowish in its upper part, becoming reddish downward, finally passing into a sandy clay with deep brownish red and gray mottlings. The soil layer is usually rather thick, so that the bedrock is rarely seen except in the valley sides and in areas where active erosion is in progress, such as areas in the vicinity of White River.

Crops.—At the present time these soils grow cotton and corn chiefly. Oats are grown to a considerable extent and wheat to a very slight extent. Sorghum does well, but is grown only for sirup for home use. Cotton is probably the most profitable crop grown on the land at the present time. Corn gives low yields and is liable to serious injury by drought. The yields will not average more than 25 bushels per acre, probably less.

Oats are reported to do fairly well—better than on the cherty limestone land north of this area. The past season (1911) was an especially favorable one for oats.

These soils are early. The clay in the subsoil enables them to hold moisture fairly well, and they are easily cultivated. These characteristics adapt them to the growing of cotton. They lie on the northern boundary of the cotton region. The plant must have a warm, rather early soil this far north, to mature properly. As a result of this, a large area is planted to this crop every year and the high price of cotton for the last three or four years has greatly stimulated its production. New land is being cleared and planted to cotton and old land that formerly grew corn is being planted to

cotton. Although the soil itself is adapted to the growing of cotton, the topography is not, so that the result will be disastrous.

The topography is rolling and the subsoil has a considerable percentage of clay. The clean cultivation demanded by cotton is permitting the wholesale washing away of the soil by the heavy rains that occur so frequently in north Arkansas. The water is not absorbed by the soil as rapidly as it falls, so that it runs off the land and takes a large part of the soil along with it. The rapid extension of cotton growing, causing the rapid clearing of new land, during the last few years, has made this difficulty acute. The stream channels are being choked, the bottom lands are being covered with a coating of sand, the upland soil is being washed away.

There is only one remedy for this. That lies in a complete change in the farming system, changing from cotton to grass and live stock. The region lies far enough south and near enough to the lowlands of Arkansas to make the growing of Bermuda grass possible, though it will possibly require reestablishment once every 10 years, possibly oftener, after especially cold winters. It grows on the lawns throughout northeastern Arkansas and is rarely killed by freezing. The bunch grasses will not protect the land from washing, at least not so effectively as a sod grass, and none of the common sod grasses will grow well on these soils. It is necessary to make use of a sod grass that is at the same time a pasture grass, for hay grasses will not be possible on account of a lack of a market for the hay.

By the setting of the steeper slopes in Bermuda grass and the cultivation of the smoother lands in winter feed crops, a live-stock farming system may be established that will save both the soil and the farmer. As it is at present, the farmer is being temporarily saved, but the soil is being lost.

Clovers grow fairly well on these soils, except on old, run-down land and on the sand areas.

Sorghum for sirup could be made a profitable crop for the smoother lands if any effort was made to find a market. The sirup made from the sorghum grown here is especially light in color and has an excellent flavor. At the present time it is grown for local use only, though it sells for 50 cents a gallon at the mill. There is probably no better land than this for sorghum growing in the upper or middle Mississippi Valley.

The first settlements in this area were in the valleys on the alluvial soils. It was soon found that the upland soils were easily cultivated and the yield for the first few years was good. At the present time early conditions are reversed, The valleys are being abandoned because their soils are being covered by the sand washed

down from the uplands. Population is more or less evenly distributed over the whole area. There are many uncultivated areas on the uplands, some of them abandoned, but in most cases newly cleared land takes the place of uncultivated land. The abandoned fields soon become covered with a vigorous growth of young shortleaf pine trees.

Springfield Soils.

Distribution.—The Springfield soils occur in a belt lying along the southwestern, western, northern, and northeastern borders of the Ozark region. The belt fails to appear along the southeastern border of the region, not because of a change in the fundamental features of the region in this part of the area, but on account of the boundary line having been somewhat artificial there by Mississippi River erosion in recent geologic times. This part of the region has been cut away, the existing boundary lying well within the natural boundary.

Along the greater part of its course the belt is narrow and its soils are very much mixed up with soils from overlying rocks. It is only in an area of country surrounding the southwestern corner of Missouri that the belt widens into a broad area. Around the outer borders of this area, especially in Kansas, Oklahoma, and Arkansas, the soils are greatly modified by remnants of other soils lying on them. The largest area of typical soils, therefore, or typical country, lies in southwestern Missouri. This is the region in which the largest continuous area of this soil, and the country whose characteristics are determined by it, is known to exist in the world. It includes an area of about 6,000 square miles, not considering the portion that has been strongly modified, and including the latter it is about 11,000 square miles. The total area of the belt, including all of the southwestern enlargement, is about 12,500 square miles. Geological maps show a much larger area than this, but a considerable portion of the area underlain by rock which forms this soil series has a soil that is wholly independent of the bedrock beneath it.

The broad expansion of the group in the southwestern Ozarks is due to recent geological events which took place here, but did not affect the rest of the area.

It is unnecessary to describe its distribution in greater detail. This can be seen by consulting the accompanying soil map. The northern part of the belt lies north of the Missouri River and outside the region usually included under the term Ozark. This, however, is as truly Ozarkian, so far as the river-hill region is concerned, as any of the areas south of the river. The whole belt will be discussed under the following heads: (1) The Springfield area; (2) the White area;

(3) the Osage area; (4) the Cooper area; (5) the Northern area; (6) the Mississippi area; (7) the Ste. Genevieve area; (8) the Cape Girardeau area.

THE SPRINGFIELD AREA.

Boundaries.—This area is bounded on the north approximately by the southern boundary of Cedar County, Mo., and the eastward extension of that line, on the west and south by the group boundary around to the headwaters of Buffalo Fork of White River in Arkansas, on the east by a line dividing the hill area of Buffalo Fork and Crooked and Bear Creeks from the smooth country west of them. From near the head of Bear Creek northward the area and group boundaries are identical.

Topography.—The fundamental features of the topography is that of a plain, sloping gently northwestward in Missouri, westward, southward, and southeastward in Arkansas. Along its western and northwestern boundary it merges imperceptibly, so far as topography is concerned, into the plains of western Missouri, Kansas, and Oklahoma. Along its southern boundary in Arkansas it is bounded by a steep rise to a higher plain, its relation to the latter being the same as that of the plain east of the Springfield area to that area itself.

Into the surface of the plain a few basins and many valleys have been excavated. Both basins and valleys have not only been excavated in it but through it. They reach down to a different country. The floors of the basins as well as the valleys have a different topography and a different soil. The basins are the Jenkins basin in Missouri, the Berryville basin of Missouri and Arkansas, and two or three small basins in McDonald County, Mo., all of which were described under the Baxter soil series.

The streams which have cut through the area of the series are those that cut back into that part of the area that lies facing White River. Sac River in northern Greene County and southern Polk County, Mo., has cut through also.

The high eastern border of the area in Missouri and the northern in Arkansas is a very rough country. That part of it extending from Cedar Gap, Mo., southward around the whole border of the Springfield area is, therefore, a very rough region. It is one of the roughest sections of the whole Ozark Dome region. The relief is locally as much as 500 feet. Practically the whole area is thoroughly dissected. There are occasional small areas of relatively smooth country on the ridge tops, lying at the level of the surface of the plain, but they rarely amount to more than a few acres. There are probably not half a dozen 40-acre tracts within 4 or 5 miles of this boundary that are smooth over their whole area.

North and west of the watershed the topography of the greater part of the area is that of a broad plain. That would be its character

over the whole area if it were not dissected by a number of streams. Every stream valley is bordered on both sides by a dissected hilly belt, whose width varies usually with the size of the stream, the average amounting to about 3 miles. The depth of dissection varies. Over a large part of the area it is less than 120 feet. In such cases the greater part of it is smooth enough for cultivation. In no case is it as deep as that of the eastern border belt.

The roughest country on the western slope of the plain lies in a a belt about 25 miles wide extending southwestward from southern Newton County, Mo., through McDonald County, Mo., western Benton County, Ark., and the adjacent portion of Oklahoma.

Not more than 25 per cent of the northwestern slope of the Springfield area is too rough to cultivate, topography alone being considered.

The rocks.—The rocks from which these soils were derived are limestones. They belong to the Mississippian or Lower Carboniferous group as described by geologists. This group includes a number of limestones and one or two sandstones and shale beds, practically all of which occur at some place in the States of Missouri and Arkansas.

In a broad general way the Springfield area, on the basis of soil character chiefly and to a certain extent on those of topography and productive capacity, is easily divisible into three areas: (1) The Eastern Border Belt; (2) the Northeastern Interior area; (3) the Western and Southwestern area.

The Eastern Border Belt.—The Eastern Border Belt includes the rough hilly fringe described under the head of topography. Its dominant soil is a stony loam. It is a gray to brown gravelly silt to silty clay soil with a variable amount of stone but practically never stone free. A large percentage of it is both too stony and occurs in areas too rough for cultivation. The percentage of stone in the soil will in many places amount to as much as 90. In fact, not uncommonly, cultivated fields occur in which practically no silt or clay is visible on a casual inspection. The surface is covered with small stones from 3 or 4 inches in diameter downward. The finer soil particles are washed down out of sight by rain, leaving the stones on the surface. The subsoil is a red to yellowish-red stony clay to silty clay. It is usually as stony, or nearly as stony, as the soil.

This soil is not, however, entirely unproductive. It catches and stores all the rainfall and permits none to escape by capillary rise to the surface. It stands drought very well. It is not, however, a good grain soil. It is adapted to red clover, and will probably produce moderate yields of alfalfa if manured. It is not a very leachy soil.

It is an excellent soil for small fruits, and will grow fruit trees well also, except on south slopes where the summer temperature becomes too high. The liability to injury by frost is a serious drawback to

the growing of tree fruits, though it is not so serious as to render the effort of the farmer to have a small orchard unavailing.

On the gentler slopes the soil is often gravelly, rather than stony, and is on this account capable of cultivation. It is then much better for all crops, becoming a fair corn and wheat soil and still retaining its adaptability to red clover and its probable adaptability to moderate success in alfalfa growing.

The ridge tops are stony to stone free, rarely the latter, and are usually less productive than the slopes. In a few places there are areas of a grayish to brown silt loam, with red oak, elm, hickory, and walnut on the upland. They are really outliers from the Northeastern Interior area and do not belong to the border-belt types. Such areas are very productive.

The gray upland soils occurring on the narrow ridges and broader plateau ridges are not usually fertile, especially when they are nearly free from stone and highly silty. They are deficient in organic matter, at least in that form of it called humus, and often have impervious subsoils.

A large percentage of this belt is uncultivated. The rough lands are covered with red, black, and white oak timber, usually of very little commercial value, and the smooth upland areas with blackjack and post-oak timber.

The Northeastern Interior Area.—The Northeastern Interior area lies in a northwest-southeast belt, with the southeast end lying along Finley Creek and the northwest end lying on the Cedar County line. Springfield, Mo., lies to the southeast of the center of the area. The south line runs westward from the mouth of Finley Creek to the vicinity of Marionville, Mo.; thence the west line runs northwestward to the southwestern corner of Cedar County.

In general, the topography of this area is smooth. It contains belts of rough country along both sides of the main streams flowing through it, but this is not as rough as the eastern border belt.

The predominant soil type is a brown to reddish-brown stone-free to moderately stony silt loam to silty clay loam, with a bright red stony clay to silty clay subsoil. It is an excellent grain and clover soil, a large part of it being sown to wheat every year. It is a good fruit soil also, although the area is subject to frost injury in springtime. The native-tree growth consists mainly of red oak, black oak, hickory, walnut, and elm. It is the strongest upland soil in the Springfield area. It contains areas of gray stony silt soil, as well as a few areas of gray stone-free soils, the latter occurring more abundantly on the west side of the area. It contains, also, in the hill belts along the streams, stony loams, such as those occurring in the eastern border belt.

The main soil is probably the Decatur silt loam of the bureau's classification. It is the typical soil of the coarsely crystalline, pure, moderately stony, massive bedded, fossiliferous Burlington limestone. West of this belt the soils are more or less mixed with the débris of formerly overlying formations, except in local areas, while east of it the country is much rougher and the soils more stony and more thoroughly leached. In no other portion of the State is the soil derived from the typical coarse Burlington limestone so little affected by foreign intermixture and by leaching. It is the typical soil of the Springfield region.

There are, however, considerable areas of gray stone-free loams and silt loams, as well as areas of sandy loams. These are all derived from outliers of coal-measure shales and sandstones which have escaped complete erosion. Such soils are more abundant along the western side of the area and on the ridge tops.

The Western and Southwestern Area.—The western and southwestern part of the Springfield area lies south and west of the Northeastern Interior area. It extends into Kansas, Oklahoma, and Arkansas. The main body of the area lies in Jasper, Lawrence, Newton, Christian, Barry, and McDonald Counties in Missouri and in western Benton and northern Washington Counties in Arkansas. It is much the largest part of the Springfield area, comprising fully two-thirds of it and more than half of that portion of it lying in Missouri and Arkansas.

It is, on the whole, an area of smooth country, not differing in that respect essentially from the Northeastern Interior area. It contains large areas of smooth or gently rolling plains, and its hills along its main drainage lines are lower and less intricately cut up than in the other areas.

The rocks underlying it belong to the Burlington limestone formation, but it is more cherty than the same formation in the Northeastern Interior area.

The bedrock consists of alternating layers of chert and limestone. The limestone layers dissolve rather rapidly, leaving a red clay residue, while the chert layers stand in their former position, forming a skeleton framework supporting the surface. After a time it collapses, but railway cuts are known where 30 to 50 feet of such skeleton support is exposed intact.

The two characteristics of larger percentage of chert and more admixture of foreign silt and clay do not occur and increase with perfect harmony. The clay content increases westward; the stone content increases southward. The clay occurs mainly on the ridge tops and on the large areas of smooth land; the stone occurs mainly in the rough parts of the area. The smooth uplands are usually

flat rather than undulating, as they are in the Northeastern Interior area; the valleys are somewhat more sharply cut than the latter, but are not so deep. The topographic profile is more angular, but the extremes are not so wide apart.

There are two main soils in this area. The one is a gray silt, either stone-free or carrying chert fragments, usually of large size—from 6 inches in diameter upward and averaging 8 or 10 inches. The subsoil is a gray, brown, or yellow silty clay or a reddish-brown stony clay. The former soil, or at least the stone-free portion of it, has been called, in the previously issued publications of the Bureau of Soils, the Clarksville silt loam. This name was given it because it was thought to have been derived from the St. Louis and Burlington limestones by weathering. There is not much doubt that its origin was misinterpreted. It could not have been derived, by weathering, from a cherty limestone. It has been derived very probably from the Coal Measure shales that originally extended over this whole area. It is a remnant of a formation or series of rocks that once lay here but have all disappeared except the clay and silt resulting from their disintegration. This material is left on the smooth ridges and prairies where erosion has been unable to get at it. This soil is less abundant in the eastern and northern parts of the area and most abundant in the western and southern parts. As the Coal Measure boundary is approached, there is no sharp line between this soil and that derived from the Coal Measure shales and now found lying on them.

While this soil is more easily cultivated than the stony soil derived from the limestone it, as a rule, is not so productive. It is more intractable, is rather cold and late, does not grow clover well, and is not a good corn soil. It grows redtop well, produces fair timothy, and fair wheat where it is well drained. Part of it was originally covered with a sparse growth of timber and part was prairie. The timber was mostly post oak and consisted of rather large trees standing wide apart, without underbrush, giving to the country a park-like appearance. The ground was covered with a dense growth of grass.

After the country began to be settled and the autumn woods and prairie fires had been stopped, brush rapidly took possession of the land, and in a few years covered the ground completely with an almost impenetrable cover. Where the land has not been cleared these areas are now covered with a dense growth of post oak and blackjack saplings. The prairie areas have all been in cultivation for many years.

Where this soil occurs in considerable areas it has been differentiated—in Missouri as Lebanon soils and in Arkansas as the Fayetteville soils, mainly silt loams. In this latter case the soil layer

above the cherty limestone material is thicker than the Lebanon material and contains more yellow in the upper subsoil and red in the lower subsoil than the latter.

The other soil is a grayish to yellowish stony silt with a yellowish to reddish-brown stony clay subsoil. The soil may be merely "gravelly" or it may be extremely stony. The subsoil varies greatly also in the amount of stone it contains. As a rule, the "gravel" and stone in the soil have a more decided yellow color than the soil itself. The determining factor in its utilization is the percentage of stone in it. This determines whether it can be cultivated at all or not. If it can be cultivated at all the poorest of it is considered somewhat better than the average of the stone-free gray land.

This soil occurs in the rolling and hilly areas. It was almost bare of trees up to about the middle of the nineteenth century; since then it has all been covered with a dense growth of trees, most of them of moderate size. In the smoother areas these trees are mainly blackjack oak. In the rougher areas they are black oak or red oak, especially where the drainage is good and the subsoil is a dark reddish-brown stony clay.

This is one of the best clover soils in the State; the plant "catches" easily, and the yield of both hay and seed is good. The hay crop is often damaged by rain, which is of frequent occurrence in the southwestern Ozarks about the latter part of May and the early part of June.

The gravelly and moderately stony part of this soil is a fair corn and wheat soil also. A large part of it is sown to wheat each year, the yield per acre varying from 6 to 25 bushels.

Apple trees do well on this soil. Next to the brown silt clay loam or silt loam of the Northeastern Interior area, this is the best apple soil in the Springfield region. Apples grow to good size, color well, and have a good flavor. Where air drainage is good the loss from spring frosts is much less than it would be otherwise, but frosts cause serious damage over the whole area. It is most serious in the narrow, high, very stony valleys where there is no perennial stream. In the southwestern part of the area in the State of Arkansas frost damage is sometimes not so severe as it is in the northern part. In 1907 northwestern Arkansas had a good crop of fruit, while the Missouri portion of the same region had none. In 1910 the Arkansas portion of the region had a somewhat better crop than the Missouri portion. During the decade from 1900 to 1910, inclusive, there were two full crops of apples over the whole region, these being grown in 1901 and 1906. The southern part had a good crop in 1907 and the whole region had from a fifth to a third of a crop in 1910. In the other years of the decade the region did not produce enough apples to satisfy the home demand.

Peaches and the other stone fruits have never been grown profitably on a large scale, except in the extreme southern part of the area in Arkansas.

Strawberries do well and are profitable. They yield well, have a good flavor, and stand shipment well. The strawberry crop is one of the most important of the crops grown in parts of the region, especially in the vicinity of Marionville, Monett, Purdy, Sarcoxie, Pierce City, Neosho, Exeter, and Seligman, Mo., and the towns along the railway in northwestern Arkansas. All these places have their local fruit growers' associations, through which the fruit is marketed, usually in carload lots.

In the area of the silt loam settlement has spread rather uniformly. Farms are rectangular in shape and the roadways follow the land lines in a rectangular network. In the smooth parts of the area of the stony loam settlement has spread over it in much the same way. In the rougher parts of it human occupation is confined mainly to the valleys.

There are no abandoned farms in this area of Springfield soils and no tendency to abandonment is manifest. The area under cultivation is being extended gradually, the farms are being improved, farm equipment in buildings, machinery, implements, and stock is gradually improving, and the farmers are alert and wide awake. They are eager students of soil, crop, and stock improvement. During the last few years they have taken up dairying enthusiastically. It has passed beyond the experimental stage and has become an established industry, not over the whole area, but in spots over most of the area. These spots are growing in size.

The Southeastern area.—The Southeastern area includes the Springfield soils of Arkansas, running across the line into Missouri in one locality, bounded on the east and south by the eastern and southern boundaries of the Springfield group as described above, on the north by the White River Valley, and on the west by the Berryville area of Berryville soils.

The central part of this area is a rather smooth rolling plain with shallow valleys. By far the larger part of it is not too rough for cultivation. The smooth center extends southward and westward to the boundaries, or nearly so, but the northern and eastern borders, as well as the northwestern, are badly cut to pieces. The smooth country of the central area extends eastward in tongues for several miles between the main drainage areas. These constitute smooth prairielike oases of cultivated land in strong contrast to the rough timber-covered hills around them. The central smooth area, which is here called the Harrison district, consists of a broad shallow trough-like depression, the axis of which trends from north to south. Long Creek Valley lies a little east, apparently, of the central axis of this

depression. The western side of the trough rises gradually from the axial line to within a short distance of the western boundary and then rises rapidly to a rather definite but low ridge along the eastern boundary of the Berryville area. The eastern side rises gradually and finally reaches a greater elevation than that of the western side, but it is not finally bounded by a definite ridge. Its rise is not strong enough to keep it from invasion by the headwaters of the streams that flow eastward from it. It is, therefore, badly cut to pieces and its boundary is ragged. When seen from the ridge on the western side, however, its detail of topography is lost and it looks like a wooded ridge. The eastern side of the trough is broader than the western, but the proportion of smooth land is no greater. The gradual but continuous rise soon brings the country high enough to be sharply dissected by the drainage. There are a few areas, however, that on account of their location with respect to the drainage lines have remained undissected. The Ham Flat, Pine Flat, Kings Prairie, and Western Grove areas of smooth country in the eastern part of Boone and the western parts of Marion County are all of this kind.

Even the axial belt of this area lies high enough above the local stream grade to have been dissected by Long Creek, but the depth of dissection is less than 200 feet for the central and southern parts of the area, while the dissection along the eastern margin is from 300 to 500 feet.

The rock is for the main part of the area the typical cherty Burlington limestone, or Boone chert. It does not differ essentially from that in the Southwestern area of Springfield soils.

The smooth areas, where not in cultivation, are covered with a growth of blackjack and post-oak timber. The rough lands are covered with red oak, black oak, and white oak. The greater part of the smooth-land timber is blackjack. Post oak grows only on the stone-free soils.

The soils of this area do not differ essentially from those found in the other areas of the Springfield region. It is described as a separate area not on account of its difference in soils so much as on account of its isolation from the other areas and its slight topographic divergence from them. It is a small, isolated agricultural unit, one of the areas of productive soils cut off from other areas by other soils and other topographic and economic conditions. The Harrison area is much nearer the Southwestern area in its characteristics than the Northeast Interior area. It contains very little of the moderately stony reddish-brown silt to silty clay or clay soils, like the predominant soil in the latter area. On the other hand, it contains a great deal of the very stony gray or pale reddish-brown silt loam with stony subsoil, usually reddish brown in color, occurring in a region that is dissected by shallow valleys. It contains also a large amount

of the so-called Clarksville silt loam, the stone-free gray silt with yellowish to pale brownish, mottled silty clay to clay subsoil. A considerable part of the area is very much like that part of the Southwestern area found in the southern part of Lawrence and the northern part of Barry Counties in Missouri.

The Harrison area is an oasis, so to speak, surrounded by country that is much rougher and very different from it in soils, existing economic conditions, and history. It is a region occupied by moderately prosperous farmers, surrounded on all sides by belts comparatively unoccupied and, at present, unproductive. Along its western side the belt separating it from the Berryville basin of Berryville soils is narrow, but it exists as a definite belt.

The Harrison region is a region of general farming. Until about five years ago there was no railway nearer than Eureka Springs, and the wagon road thence had to cross some extremely rough country. It was impossible to engage in fruit growing or any other branch of farming based on special and perishable crops. Since the two railways have been built through it some interest has been manifested in fruit growing, but very little has been done. There is no doubt about the adaptability of the soil to strawberries and apples, but late spring frosts occur just as frequently and are just as destructive, or practically so, as they are in the northwestern corner of the State, in the Bentonville country. Whether there is or is not a slight difference between the two areas in this respect is not really an important matter. The fact is that the fruit grower in the Harrison area must equip himself with a means of combating late spring frosts or else make up his mind to lose his crop very often.

The White River Area.

Extending southeastward from the Harrison country there is a long, narrow belt of Springfield soils. It lies, in the main, south of White River and extends to the Ozark boundary in Independence County, Ark. Its northern boundary is extremely ragged and beyond the general boundary there are many narrow tongues and a still greater number of small detached areas. These extend, as will be seen by consulting the map, far northward into the State of Missouri.

Its southern boundary is slightly irregular also, the irregularities consisting mainly of tongues extending south of the general boundary up the larger valleys. Detached areas do not occur south of the boundary as they do north of it.

The tongues projecting southward from the southern boundary are all low with respect to the country on either side of them, while those projecting northward from the general northern boundary are high, with low country on both sides of them. All the isolated areas,

also, north of the main body lie on the tops of high knobs that are conspicuous topographic features in the country in which they occur. They are small in area and occur in positions relatively inaccessible. Very few of them are cultivated.

The general lay of this soil belt is that of a plain sloping to the south, but it has been cut to pieces so thoroughly by the streams that drain it that very little smooth land is left. It is now for the most part an extremely hilly country. Its elevation and its nearness to White River have enabled the streams to dissect it thoroughly, except in that part lying east of Batesville, which is neither so high above nor so near White River as to cause it to be so deeply dissected as farther west.

From the western side of this belt westward the southern border of the Springfield area is smooth. Within the drainage area of Buffalo Fork and eastward to where White River crosses it the valley bottoms in this belt lie several hundred feet below the upland surface, not merely along the northern boundary, but entirely across it to the southern boundary, so that the belt is rough across its whole width.

East of White River the southern boundary lies down at the river level and is, therefore, undissected and smooth.

In this area two series of rocks of different character are included because of their very intimate association in the field and because of the impossibility of differentiating them and the soils derived from them in a reconnoissance survey.

From the point of view of geographic distribution and area, the most important rocks are the typical cherty Burlington limestone or Boone chert, exactly like the cherty part of this formation in the Harrison and Bentonville regions. It is the rock underlying all the area, except a very narrow and discontinuous belt along its northern border, where the other series of rocks just referred to occur. The latter consists of chert-free, massive, crystalline limestones and magnesian limestones.

The whole of this area, where not cleared for cultivation, is covered with timber. The important trees are red, black, and white oak and pine. The bottom lands and the less cherty slopes contain some elm, walnut, and other trees that are usually associated with them.

The predominant soil type of this area is the stony loam. It has been described in connection with the discussion of the other areas and does not need another description here.

The phase represented is, as a rule, the very stony phase. This fact, combined with the very rough topography of the area, renders it unfit for cultivation, except in very small patches. On northwardly facing slopes and on narrow ridge tops where it is not too stony to cultivate, fruit trees do well and the excellent air drainage very greatly reduces the liability to injury from frost. Orchards planted

in such localities bear crops when those on the smoother lands are destroyed by frost. Practically none of the uplands are adapted to general farming, for the simple reason that tillable areas do not occur in bodies large enough for establishing a farm on them.

The so-called Clarksville silt loam has a very limited distribution in this belt. It occurs in patches of a few acres in a few places on the ridge tops all over the area, but none of them are large enough to be of any value.

Along the northern border of the belt, mainly in Independence County, Ark., but occasionally west of it, there is a narrow belt of a brown to reddish-brown stone-free silt loam with a reddish-brown stone-free silty clay to clay subsoil. It is a fertile soil, but occurs in areas too hilly for utilization. Very little of it is in cultivation or can ever be placed in cultivation on account of its rough topography. The better part of it could be converted into pasture. It would grow orchard grass and the clovers well and would possibly grow bluegrass fairly well. It should probably be correlated with the Decatur silt loam.

The Osage Area.

This area occurs in the form of a belt about 30 miles wide at the south end of the south line of Cedar County, Mo., and 10 or 15 miles at the north end in the southern part of Pettis County, Mo. Its eastern boundary is the western boundary of the Howell soil belt and its western boundary is the Ozark boundary.

The belt is very much broken up in two ways: (*a*) by being cut into fragments by creek and river valleys, and (*b*) by being covered with areas of soils belonging to the western prairie region rather than to the Ozark region. The eastern boundary is therefore very ragged, and there are many small isolated patches occurring as detached areas east of this. Some of these are shown on the soil map, but there are probably many others that are not shown. Most of them occur in Polk and Hickory Counties. The western boundary is not a smooth line, but it is less irregular than the eastern.

Like all the areas of Springfield soils described above, this area is essentially a plain dissected by stream valleys. Between the valleys are smooth areas—smooth because they have not yet been dissected. The valleys are not so deep and as a rule not so abundant as they are in the dissected portions of the other areas. The undissected areas are not so large as they are in the Springfield area and not so small as in the Harrison area. In the immediate vicinity of the larger rivers the dissection is most thorough and deepest, equaling in thoroughness that of the Harrison area, but not equaling it in depth. The dissected portions are, therefore, hilly, but not always too hilly for utilization.

The smoother areas are not tree covered; the dissected areas are, except when cleared for cultivation or pasture. The important smooth areas are Weaubleau and Quincy prairies in Polk and Hickory Counties. Other small areas occur widely scattered over the belt.

The rocks are typical Burlington limestones. They are coarse-grained, massive, and moderately cherty. The proportion of chert is smaller than in any of the areas south of this one, except in small patches of the Springfield area. This smaller chert content of the rock and the moderate dissection of the area are two important factors in differentiating it from the other areas.

The predominant trees are red, black, post, and white oaks, in the order named. Red oak is more abundant and white and post oak less so than in the areas south of this. Walnut trees occur more abundantly than is usual on the Springfield soils.

The soils as a whole are very much the same as the soils from the Burlington limestones farther south, except the smaller proportion of chert. Accompanying the diminished chert content and the thoroughly crystalline character of the limestone is an increased amount of the dark brownish-red chert-free or nearly chert-free clay to silty clay soil of the Decatur series.

Associated with these cherty soils are soils that are nearly chert-free and gray in color, with yellowish subsoils. They are essentially like the Lebanon soils and have been mapped as such, though they are thinner than typical. In this region they are not usually covered with a growth of post oak or blackjack brush or trees. They are somewhat darker in color than the Lebanon soils, more loose and friable in structure, and more stony. The stone, however, is usually in rather large fragments (from 6 inches to 2 feet in diameter) and is not so thickly strewn over the ground as to render its removal difficult or expensive. The subsoil is often stony also and not so heavy as the typical.

On the more gravelly and stony phases of this soil the crops are subject to injury by drought. A large part of it is utilized for pasture. In years of abundant rainfall the growth of bluegrass is fair; in dry years it is poor. It produces good crops of corn when well supplied with moisture. The soil is fertile, but does not adapt itself readily to a great variety of crops.

The less stony and stone-free, more compact phases are more adaptable than the more stony and more friable phase. This soil is confined to the smooth prairie areas.

On account of the smaller proportion of chert occurring in the rock in this area, the accumulated material overlying the undisintegrated rock is not so thick as it is where the chert is more abundant. The chert is too coarse to be carried away by the rain wash and it serves as a protection to the finer parts of the soil. In this area

rock outcrop is rather common and small areas of "glades" occur where erosion is active. They are much more abundant here than in any other area of Springfield soils in the Ozark region.

Throughout most of this area the creeks have cut their valleys through the rocks from which these soils have been derived and into the rocks from which the Berryville soils have been derived. Many of the streams head also beyond the western boundary of the belt, in the region of prairie soils derived from shales, clays, and sandstones rather than limestones. The bottom-land soils, therefore, are not identical with those farther south. They differ from the latter in being heavier, less stony, and grayer or blacker in color. They are often poorly drained, both as regards surface drainage and underdrainage. They are less fertile, therefore, than the loams occurring in the valleys where nothing but Springfield soil material is carried by the streams. By underdraining those areas that are poorly drained these lands could be made much more productive.

The whole region is one of general farming and stock raising. Until a few years ago its shipping facilities were poor and at the present time there are portions of it that lie 15 miles from a railway station. The soil and stage of economic development make of it a stock-raising area. Dairying could be developed, and something has already been done in this direction. This is the most promising industry for the future, carried on in connection with sheep and cattle raising, with limited attention paid to hogs. It is more of a forage country than a grain country. The bottom lands, when gravelly and well drained or when not too close in texture, will grow alfalfa; the gravelly to stony hill lands are natural red-clover lands, and the prairie areas will grow fair crops of corn, timothy, and bluegrass. There are no large areas well adapted to wheat. The best are the gravelly upland soils and the well-drained alluvial soils.

Commercial fruit growing is not practicable, excepting the production of berries in the immediate vicinity of the shipping points.

The Cooper Area.

The Cooper area of Springfield soils occurs in small patches in Cooper, Pettis, and Moniteau Counties, not all of which are included within the area mapped. Similar areas occur still farther north in Saline County.

This whole region has been covered until recently by a series of clays and silts, possibly derived from a series of shales and sandstones that may have originally extended over it. Beneath this silt and clay layer the substructure of the area is made of limestone, with one or two wholly unimportant exceptions. Some of these limestones are those from which the Springfield soils are derived, others are those from which the Berryville soils are derived. Both the Springfield

and Berryville soils occur, however, only in places where the overlying silts and clays have been removed by erosion. Manifestly this can happen mainly in the hill belts bordering the main valleys. It is obvious also that in such cases the soils would be apt to be more or less mixed with the overlying silts and clays.

Aside from this mixture, which varies greatly in the proportions of Springfield and foreign material, though usually the foreign material is small in amount, the soils are essentially the same here as in the Osage area. The rock is massive and moderately cherty, but not so coarsely crystalline as in the latter area. The soils are the stony loam and the Springfield silt loam. There are no areas of level land where it occurs, all such areas being covered by the overlying silt and clay. The topography is rolling to hilly, only a relatively small proportion of it being too hilly for good pasture land. The rolling areas are usually cultivated or in woodland pasture. They are considered to be among the productive lands in the area, being stronger than most of the silt soils of the uplands, but not so easily cultivated. They are adapted to corn, wheat, and clover.

The more stony lands are, like the same type in the other areas, too rough and stony to cultivate and are not very productive.

The Northern Area.

The Northern area occurs in the Missouri River hills on the north side of the river, stretching from Howard County to St. Charles County. It is limited to the hill belt of the river, not reaching back to the smooth lands beyond it. Like the Cooper area, this has been covered until recently by a layer of silt and clay. Beneath this layer occurs the limestone whence are derived the Springfield soils. These were completely covered by the silt and clay and have been uncovered only along the hill belts, where erosion has worn away the overlying material. These areas are smaller than in the Cooper area. They are also more thoroughly mixed with the overlying material. The soils, therefore, even when they do occur, are not typical, except locally. Within this whole region these soils are unimportant economically. They occur in very small areas and these almost invariably on steep hillsides or slopes too steep for cultivation. When utilized at all they are used for pastures. The Springfield soils occurring in the area are the gray stony loams and the brownish silt loams. As a whole they are of practically no importance in this belt.

The Mississippi Area.

This belt is broken into three parts. The northern part occurs in St. Louis and the northern part of Jefferson Counties. Another lies in the southeastern part of Jefferson County and extends

thence across Ste. Genevieve County, and the third area is in Cape Girardeau County, where there is a belt of soil derived from moderately cherty limestones that are here included in this area, although the rock is not of exactly the same character as that in the other areas. In none of these areas does the typical Springfield soil occur, if we regard the soils in the vicinity of Springfield, Mo., as typical, except in small bodies. The belt is narrow, so that remnants of overlying rocks are found in many places, and the soil over a still larger area is modified by remains from them.

The rock also is not typical Burlington in the greater part of the area. In the northern area the St. Louis limestone is by far the most widely distributed formation occurring beneath the layer of soil material. It is a rather fine-grained rock, rather thin bedded, often earthy, and has a small quantity of chert. It disintegrates into a finer grained soil than that from the Burlington; one that is closer and less easily drained; one that is more apt to remain gray than change to the reddish brown of the Springfield.

Beneath the St. Louis limestone in this northern area, outcropping in the southwestern part of it, but in a narrow band, occurs a chert-free rather coarse grained limestone alternating with beds of blue shales. This produces a soil much like that from the St. Louis limestone. The Burlington limestone outcrops only around the outer west and southwest border of the area. It is not massive and moderately cherty, as it is in the Osage area, but thinner bedded and very cherty. It does not have much influence in producing the soils of the area, since it is exposed mainly on steep hillsides.

Another factor, and an important one, in the soils of this area is the overlying silt and clay, which seems to be essentially the same as the layer that occurs in the Cooper and Northern areas. Its distribution is not known, but it probably occurs over a considerable proportion of the western part of the area.

The bluff loess, the formation from which the Knox soils have been derived, occurs in the eastern part of this area, its distribution not having been determined in detail. The soils, therefore, are not typical Ozarkian Springfield, but are a composite of several things.

The predominant soil of the St. Louis area is a gray to yellowish-gray to pale brownish silt loam, chert-free or nearly so. It would possibly be correlated with the Hagerstown silt loam, though part only of the material is derived from the disintegration of limestone. The northern part of the country has a small proportion of limestone material, the central eastern part less, while the southern part has the largest proportion. It occurs here mainly on the higher lands, while the lower lands (excluding the alluvial flats) are derived from Berryville and other material. The greater part of the market garden soil

in the eastern part of the county is derived from the loess and need not be described in this place.

The Springfield soils in St. Louis County and vicinity are corn, wheat, and clover soils, producing good crops when they are well cared for. Like the Springfield soils wherever they occur, they are not soils that will stand abuse, but will yield good crops when well cared for. They must be kept filled with vegetable matter and must be carefully cultivated. The land is owned almost exclusively by Germans and devoted to the growing of grain crops, except where market-garden crops lap over on it. There is more or less fruit grown also, especially small fruit. Apple and peach growing has received very little attention.

The soil derived from the Burlington limestone is in this region stony and occurs in the roughest parts of the area. It is of practically no importance.

The Ste. Genevieve Area.

In the Ste. Genevieve area there is an outer belt extending from the Mississippi River bluffs in the southeastern part of Jefferson County southward, forming the western border of the area, that is hilly and stony, practically the typical Burlington limestone country. Relatively little of it is in cultivation, the cultivation being confined to the gradual slopes with a gravelly to moderately stony soil, to the stone-free, gray to yellowish-gray silt covered ridge tops, and the narrow gravelly valleys. The latter is a productive soil. The soil of the gravelly slopes is also a good soil, but requires careful handling, while the silt ridges are very poor.

East of this belt there is a smoother area of several square miles in extent, with Ste. Genevieve near its northern limit. It is roughly semielliptical, the straight boundary being the Mississippi River bluff, the outer boundary being concentric with the outer boundary of the whole area. This soil is derived partly from the loess, partly from the St. Louis limestone, and, possibly, partly from the Burlington. The two former formations are responsible for the greater part of it.

The topography is gently to strongly rolling to hilly in places. The predominant soil is a brown to yellowish-brown to grayish-brown silt loam, free from chert or practically so. It occurs in the smoother parts of the area. In the rougher parts the soil has a larger proportion of yellows and grays, has more post oak and less elm, has more clay and less silt. Scattered over it are a great many sink holes. The land is owned almost exclusively by Germans and is devoted to the growing of corn, wheat, and clover. The better parts of it are very productive.

The Cape Girardeau Area.

The Cape Girardeau area lies in the extreme eastern part of Cape Girardeau County. It is an area of hill country, largely timber covered, and consists of a silt loam and a stony loam. The latter occurs in the rougher, the former in the smoother, areas. The silt loam grows fair crops of forage and grain and good crops of the legumes. It is more fully described in the detailed soil survey report on Cape Girardeau County, Mo., and the inquirer is referred to that report for further information.

THE BOSTON MOUNTAIN PLATEAU.

RELATION TO THE OZARK DOME.

The Ozark Dome slopes downward in all directions from its area of maximum elevation. The rocks responsible for its existence dip beneath those which form the surrounding country instead of suddenly terminating at the boundary. They continue to exist, therefore, far beyond the Dome boundary, but lie so far beneath other materials that they have no effect on the general character of the country or of the soils.

In all directions except the southwestward this overlying material thins gradually to a feather edge as it approaches the Dome region lying on the latter, just as a beveled board lies on a plane but sloping surface with the thin edge turned toward the higher slope, so that there is no abrupt change in the general slope of the surface at the boundary. On the southwestern boundary, however, this is not the case. The overlying materials do not gradually thin out to a feather edge, but retain a thickness of nearly 1,000 feet practically up to the boundary, where they terminate in an abrupt slope, mountainlike in its boldness.

This is the Boston Mountain Front or Escarpment and is the northern slope of the Boston Mountain Plateau. The lowest layers of the material of which the escarpment is built extend a short distance beyond the foot of the escarpment, forming a narrow fringe of soils belonging to the Boston Mountain group rather than the Ozark Dome group, occurring, topographically, more closely allied to the latter than to the former, but differing from the former in soil characteristics.

LOCATION AND BOUNDARIES.

The Boston Mountain Plateau, of which this is the northern frontal slope, lies in Arkansas and Oklahoma. Its eastern end lies against the eastern Arkansas lowland region in Independence, Jackson, and White Counties, while the western end extends to the Neosho River

Valley in northeastern Oklahoma. The northern boundary enters the State of Arkansas from Oklahoma, in the western part of Washington County, and trends at first northeastward to the vicinity of Harrison and then southeastward to its end at Olyphant.

The southern boundary crosses the State line west of Van Buren, in Crawford County, and trends thence in a general easterly direction to the vicinity of Searcy, in White County. It is, therefore, a relatively narrow belt, with its longer axis lying in an east-west direction.

GENERAL DESCRIPTION.

Its northern boundary marks a sharp change in topography, rocks, and soils. In all these respects the plateau differs profoundly from the country north of it. The boundary is a definite line, easily identified and traced on the ground. It is so sharp a boundary, accompanied by such easily recognized differences of country on opposite sides that there can be practically no difference of opinion as to its exact location.

The southern boundary, differentiating it from the Ouachita region on the south, is not so sharp and so easily recognized a line. There is no marked change in the general character of rocks and soils on opposite sides of the boundary line, and the change in topography is much less definite than it is on opposite sides of the northern boundary. While the northern slope throughout its whole extent is of the same general character, varying only in the strength of its expression, the southern slope is of different character at different places. One of the variations in character is that of definiteness of expression. In part of its course the difference in the character of the country on opposite sides of the boundary is very marked. Elsewhere it is not so, and the boundary line is more or less arbitrary. From the point of view of definiteness of boundary and contrast in character of country on opposite sides, the whole stretch of southern boundary falls into three substretches. From the western line of the State eastward to the neighborhood of the mid-line of Range 27 the southern slope is gradual, and the boundary line is placed at the base of this slope. South of it the country is low; north of it the rise to the top of the plateau is gradual as a whole. From the mid-line of Range 27 to the vicinity of the mid-line of Range 16 the southern slope is steep and descends abruptly from near the maximum height of the Boston Mountain Plateau to the low plateaus flanking the northern part of the Ouachita region, which lies at a maximum elevation of about 600 feet above tide level.

The rest of the southern boundary lies at the foot of a gradual slope, the latter becoming more gradual eastward, where it is much less

steep than in any part of the western stretch. This slope, however, descends to a relatively narrow lowland belt, south of which there is a sudden rise to a plateau, more or less broken up by erosion, from 100 to 400 feet higher than the lower part of the Arkansas Valley lowland farther south, but about a thousand feet below the top of the Boston Mountain Plateau north of it. This low plateau, or these low plateaus, are here placed in the Arkansas Valley, part of the Ouachita region, and the southern boundary of the Boston Mountain Plateau is placed at the foot of the gradual slope on the north side of the lowland belt lying north of the low plateaus. The line connecting Scotland, Choctaw, Eglantine, Shiloh, and Heber is here regarded as the southern boundary of the Boston Mountain Plateau.

The northern slope of the plateau is steep throughout its whole stretch across the State. It is not everywhere equally high, however. From the west line of the State to Harrison it varies from 300 to 500 feet above the lower country to the north. From Harrison eastward it often reaches a height of 800 feet above the country north of it. East of the longitude of Batesville, however, it declines in elevation and at its extreme northeastern corner it stands at not more than 300 feet above the country north of it. To state it in another way: That part of the northern slope of the plateau that is drained into upper White River and into the Illinois is relatively low, that part which is drained into Buffalo Fork and the lower White River is high, except the extreme eastern end, toward which there is a gradual decline from the vicinity of Jamestown.

North of the foot of the northern slope of the plateau there is a belt of varying width which in topography is a part of the Ozark Dome region, but which in its soils and its rocks is a part of the Boston Mountain region. It is a smooth belt, reaching a maximum width in the northwestern part of the State. where it spreads out over the uplands of parts of Washington and Benton Counties, making up most of the smoother areas of those counties. It extends as embayments southward up the larger valleys south of the main line of the northern border of the plateau. East of Jasper, within the drainage area of Buffalo Fork, it becomes narrow and occurs only as small areas immediately under the north slope on the ridges between the main streams and as benches on the mountain sides or valley sides within or south of the northern front. It maintains this character eastward to the mouth of Bear Creek, in Searcy County. East of this it becomes continuous again, but rarely attains a width of more than a mile or so, to where the northern slope of the plateau drops to the Oil Trough Bottom. Thence eastward the bottom land extends to the foot of the slope. The details of distribution of this belt are shown on the accompanying map as a belt of soils south of the Springfield soils and north of the Jamestown soils belt.

The top of the plateau as a whole slopes to the south and to the east. The line of maximum elevation, however, does not lie immediately on top of the north front escarpment throughout its whole length. The highest point is probably near the southwestern corner of Madison County. Westward and eastward the elevation declines, the maximum on the west line of the State being about 1,700 feet and on top of the plateau west of Olyphant about 750 feet.

The predominant feature of the plateau top is a relatively smooth, but by no means a flat plateau surface, except in small areas, sloping gently southward. Its maximum elevation is usually along or near its northern boundary. From the longitude of Mountain View eastward the plateau character of its surface is uninterrupted, except by the valleys cut into it and by very faint ridges with low, inconspicuous, northeastwardly facing escarpments on their northward slopes, all trending northwest and southeast. The amount of southward slope of the smooth surfaces between these escarpments is greater than the amount of rise of the escarpments, so that there is, as a whole, a slope southward of the whole plateau. Eastward the plateau becomes lower, but the decline is in successive rather steep slopes, with nearly level stretches between. It will be noticed, however, that the northern boundary of the plateau at its east end is farther south than it is on the longitude of Mountain View. This accounts in part for the lower elevation of the eastern end, since the base on which the plateau stands is the same along its whole front, and since it has a southward slope throughout its whole extent likewise. The farther south the northern boundary lies the lower it must be. There is no perceptible eastward dip of the plateau rocks to bring about the eastward decline of its elevation.

West of the longitude of Mountain View the upper surface of the plateau is interrupted along its central belt by a range or a series of ranges of hills that stand on it and rise prominently above its surface. They begin to appear as low, isolated hills in the vicinity of Rushing, Lexington, and Dennard. Westward they increase in number and height, but do not coalesce into a continuous range of hills east of the head of Mulberry River. Thence westward they form a continuous range, from 300 to 500 feet above the narrow belts of plateau country flanking the range on both sides. The southern belt of flanking plateau, continuous like the northern belt with the broader plateau country east of Rushing, extends westward without any important change in its features to the neighborhood of Mountain Top post office, where the high plateau-top ridges extend southward to the southern boundary escarpment of the plateau, breaking thereby its continuity. West of this it appears again just west of Hurricane Creek and continues westward to the State line and beyond.

The northern flanking belt of the plateau is narrow and thoroughly dissected as far west as Jasper, in Newton County. The northward projection of the plateau between Jasper and Huntsville lies entirely in this belt and is typical. West of Huntsville it is still more thoroughly dissected, possessing only very small areas of flat land, but considerable areas of country not too rough for utilization lying below the central belt level.

The profile of the central belt is serrate. It contains practically no areas of level plateau land. The slopes, however, are not always too steep to cultivate and include also narrow benches of relative smooth land. The belt widens from its eastern end to the longitude of Ozark, where it is more than 20 miles in width, extending from the southern boundary of the plateau northward to the headwaters of Leatherwood Creek.

The plateau surface, whether of the lower or of the higher level, has been profoundly modified by the processes of valley making. In the region occupied by the central belt of higher ridges practically none of the original plateau surface has been left intact. The ridges are narrow and the isolated hills are sharp topped; not sharp pointed, it is true, but would have been nearer so were they the product of a corresponding stage of erosion in an area of massive rocks rather than one of horizontally bedded rocks, as is the case here.

In the eastern part of the region and along the northern and southern borders, except where the central belt ridges extend out to the boundary of the plateau, the dissection is less complete. The ridges are often more than a mile in width, the upper surface being smooth or undulating. Many of the valleys on these plateau fragments above where they join the larger, deeper valleys are mere broad, open depressions. The depth of dissection varies with the elevation of the plateau surface and the size and direction of flow of the streams. In general the dissection on the south side of the watershed is not so deep as on the north, and that in the eastern part is not so deep as in the western, being due, in both cases, to the lower surface of the plateau on the south and east.

On the north side the valley depths vary not only with differences in elevation of the original surface, but also with the character of the streams effecting their erosion. On the basis of depth of dissection and, therefore, roughness of the resulting topography, the northern part of the plateau falls into three areas or stretches. The easterly one has very small streams. The watershed lies near the northern boundary, except at the extreme eastern end, where it is diverted sharply southward by Salado and Departee Creeks, both of which lie in and are responsible for an area of relatively deep dissection. With this exception this stretch extends from the eastern end of the plateau westward to Bear Creek, in

Searcy County. Throughout this whole stretch the alignment of the mountain front is relatively smooth. The small streams have not worked headward far back into it, but have opened out with their branching headwaters, a number of small embayments or "coves," so that the escarpment line, in passing around these, runs in broad curves rather than in sharp, angular turns, as it would if the streams were larger and had cut deep, narrow valleys back into the plateau. In the vicinity of Salado and Departee Creeks the line becomes more angular.

The middle stretch extends from Bear Creek westward to the Gaither Mountain country, a few miles west of Harrison. It is a region in which the main watershed is driven far to the south by the backward cutting of the headwater drainage of Buffalo Fork. These streams have pushed their conquests southward to the mid-line of the plateau belt and interlace their headwaters with those of Illinois Bayou and the Pine Creeks which flow southward. The plateau is high in this region and the valleys cut to a low level on account of the direct course taken by Buffalo Fork to the master stream, White River.

These streams have cut the northern half of the plateau belt into shreds. The northern front is no longer continuous, but consists of a series of bold salients thrusting themselves northward from the axis of the plateau and ending as very conspicuous escarpmented ridges about 1,000 to 1,300 feet above the floors of the valleys which separate them.

The western stretch extends from Gaither Mountain to the state line on the west and probably to the western end of the plateau. It also is thoroughly dissected and the streams draining it have driven the watershed practically as far southward as those in the middle stretch. The difference between the topography of the two stretches is very marked, however, and is due to the shallowness of the western valleys. The top of the plateau is just as high in this stretch as in the middle one, but the streams dissecting it flow into White River, except at the extreme west, where they flow westward into the Illinois River. White River failed to select a direct or even a consistent, course to the sea. It seems to have wavered in its early career and laid down its life work without thought of its possibilities as to effectiveness. As a consequence it is in much the same condition, so far as deep and rapid digging is concerned, as a man with a very long-handled hoe. It took too long a path to the sea, making it long by indirectness of course, flowing at first north, then east, then southeast, and finally south. Its valley is too long for rapid and deep cutting. Within the Boston Mountain Plateau, therefore, the valleys of its tributaries are relatively shallow, simply because they can not reach down to a great depth. They are camparatively

wide and have relatively gentle slopes, differing in these respects from the valleys in the middle stretch as much as in the matter of depth.

The south half of the plateau does not differ in its depth of dissection so sharply from place to place as does the north half. All the streams draining the former flow into the Arkansas River, with very slight deviation from a direct course, so that they do not differ widely in the level down to which they can cut their valleys. They differ in size, however, and the plateau differs in elevation. The effect of low elevation and small stream coincide in the eastern end of the plateau from the Devils Fork of Little Red River eastward. This part of it, therefore, is not deeply dissected.

In the rest of the plateau the dissection is everywhere deep just south of the watershed. All the streams and valleys descend rapidly from their heads. Along the southern border, however, the depth varies with the elevation. At the west end, from the State line eastward to Mulberry River, or a little beyond, the south slope is gradual. The southern border, therefore, is low and the valleys correspondingly shallow. From the eastern end of this stretch eastward to the vicinity of Scotland the southern border of the plateau is high. The streams are rather larger also. This stretch is drained by Mulberry River, the Pine Creeks, Illinois Bayou, and the various branches of Little Red River. There is a short stretch in southwestern Van Buren County and another in Johnson County, where the streams named are the dominant factors. They have dissected the country thoroughly and deeply. The most thorough work has been done by the Pine Creeks and Illinois Bayou. There is a smaller area of land smooth enough for cultivation within their drainage area than in any other part, of equal size, within the whole plateau region. They support the smallest population within the region and it is constantly becoming smaller. The greater part of what has been cultivated in the past is now and has been for several years unoccupied. It is not only unoccupied, but it is wholly abandoned and is growing up to brush.

THE ROCKS.

The rocks of the Boston Mountain Plateau consist of sandstones, shales, and limestones. From the point of view of both thickness and extent the limestones are unimportant. From the same point of view the shales stand first in importance, the sandstones second, and the limestones third. The sandstones, however, are of most importance of all as determining factors in the topography. They constitute the framework, the hard parts, the skeleton of the plateau block. The shales, on the other hand, make up the soft parts; they give roundness of outline, reducing the angularity, except when, by their lack of a definite expression, they emphasize, by contrast, the angu-

larity of the sandstones. The shales vary from highly argillaceous to highly sandy and from gray through blues and browns to black. Red shales were not encountered. The nearest approach is brown. When sandy they are often highly micaceous.

The sandstones vary from fine-grained, compact, dark, dense, fine-grained, thin-bedded rock that is often more nearly indurated shale than sandstone through thin-bedded, fine-grained, macaceous, or shaly rock, often containing well-rounded quartz pebbles. The coarse-grained sandstones are usually light gray or brown in color; one bed, however, is seemingly persistently brownish yellow.

The limestones vary from fine-grained, earthy black with conchoidal fracture, or gray and earthy to pure coarsely crystalline rock in massive beds. The beds vary in thickness from a few inches to nearly a hundred feet. There are a number of beds separated by beds of shale of variable thickness, but all occur in the lower part of the rock series making up the plateau block.

All these beds—the sandstones, shales, and limestones—slant downward to the south. There are a few localities where the simple southward slant is changed in direction through the intervention of subordinate bending of the beds, and a few faults or breaks in the continuity of the beds occur; but these are of little importance in the study of the soils. Because of the southward slant of the beds the limestones and the other formations of the block lying below them are found only along the northern front and in two or three very small localities south of it.

The sandstone occurring on the extreme northern boundary north of the limestone (Leslie) belt is a medium fine-grained, rather thin-bedded, yellow to grayish-yellow rock. The shales associated with the limestones are predominantly black in color and are argillaceous. South of the limestone belt the predominant shale in the plateau, except of the high ridges and hills of the axial belt, is also black, while the sandstone beds in this same region are usually massive, thick, relatively coarse grained, and gray in color. There is one, possibly more, series in this same region of rather thin-bedded or flaggy sandstone, fine grained and brown in color, with a good deal of iron concentrated in spots, forming dark-brown, irregularly shaped, small nodules, which weather out as brown or black "gravel."

In the high ridges and hills of the central belt the predominant sandstone is a brown and usually rather thin-bedded, though at least one thick gray bed, massive and coarse grained, is known to exist. The shales are both gray and black, the thicker beds black, the others brown or gray. Along the southern border the predominant shale is black, while there is a smaller proportion of massive gray sandstone and a larger proportion of the brownish to yellowish rock, accompanied by the occurrence of a considerable thickness of the very fine-

grained, thin-bedded, compact brown, gray, and black rock, usually called a sandstone, that was referred to above. It does not seem to occur in the northern part of the mountain belt.

NATIVE TREES.

The whole of the region is forest land. Until the advent of the railways, with their accompanying lumber and stave mills, a large part of the timber was heavy and of excellent quality. This applies especially to the white-oak timber. The railways did not come within reach of the high plateau until a very few years ago. Since that time the timber has been disappearing rapidly. Large lumber mills and stave factories have been established at central points on the railways, and small portable mills have invaded the deepest recesses of the deep plateau valleys, as well as the top of the plateau itself. In these the logs and bolts are cut into rough lumber and staves. These are hauled in wagons over indescribably poor mountain roads to the finishing mills on the railways. In some cases they are hauled a distance of 40 to 50 miles.

Railway crossties, fence posts, and mine props are other timber products of the region. The latter are shipped in car lots to the prairies of Missouri, Kansas, Oklahoma, Iowa, and Illinois. They are all made very small in order to enable the average freight car to hold the maximum number.

The most abundant trees are oaks and shortleaf pine. In addition to these there are sweet and black gum, hickory, chinquapin, elm, walnut, black locust, and red cedar. A great many genera and species not included in this list occur as scattered individuals, but they do not dominate the character of the arboreal flora anywhere. There are a great many shrubs and small trees, such as witch hazel, alder, and privet, and the usual bottom-land trees of the southern part of the Middle West. Hazel and sumac do not occur, except rarely. The trees of the plateau top do not differ to any marked extent from those of the Ozark Dome farther north. The difference, such as it is, lies mainly in the occurrence of black locust and sweet gum, the much greater proportion of white oak, and a great deal smaller proportion of blackjack and post oak in the former than in the latter. Chinquapin also is of frequent occurrence in the plateau, but very rare in the Dome region.

As a whole the pine region of the plateau is the southeastern region. It extends northward to the northern boundary in the eastern part only, and here the tree is not abundant. The northern and western boundary line of its area of distribution runs along the northern front from the east end to the central part of Stone County. Thence it runs southwestward across the northwestern corner of Van Buren to the main watershed. It follows this to the western side of the Illinois

Bayou Basin, when it turns south to the plateau boundary. Small areas of scattering trees occur west and north of this line and a considerable belt immediately south of it has a small quantity of pine. The largest areas occur along the southern border.

White oak is a clay-loving tree, yet it does not grow well on the flat, poorly drained gray clay or silt lands. It prefers the red clays, or those with reddish subsoils, with good surface drainage. Its habitat, therefore, is the clay bench lands and slopes in the valleys and along the north front of the plateau and on the well-drained portions of the clay soils of the plateau top. It is characteristically a clay-land and slope-land tree. It is found throughout the whole region, but since the clay benches, especially those with red subsoils, occur abundantly in the eastern and sparingly in the western part of the area, this tree is much more common in the former than in the latter. It is associated with the pine in the region of the latter, but extends beyond it, occupying the clay lands, while the pine occupies the sandy lands. In the white-oak areas red oak is abundant and in pine areas both black and red oak occur. The black and red oaks and hickory occur in areas of intermediate soils supporting all these trees with pine and white oak, but no dominating species or genera.

Blackjack and post oak are of very limited occurrence in the whole eastern part of the plateau. West of the St. Louis & San Francisco Railroad post oak occurs on the flat portions of the plateau top associated with black oak and hickory, while blackjack becomes abundant well down the south slope on the sandy soils. Aside from these areas of post oak, blackjack, and white oak benches and slopes, the western part of the plateau is occupied by black oak, red oak, and hickory, except the high ridges and hills above the level of the main plateau surface. These are occupied mainly by black and red oak and hickory, but their characteristic type of tree growth is an association of walnut and black locust as the dominant trees, with hackberry, mulberry, redbud, pawpaw, and sassafras. This same association occurs below the level of the high ridges on northwardly facing slopes having a brown sandy soil derived, at least in part, from limestone.

Black gum occurs sparingly over the southern and eastern parts of the plateau and sweet gum in the valleys and lower slopes of the northern front, in the poorly drained sags of the plateau top, and in the valleys of the southern slope.

Chinquapin is characteristically a dry or well-drained sandy-land tree.

Red cedar occurs in small areas of the southern slope underlain by a very fine-grained, compact, thin-bedded, brown or black rock, breaking often with conchoidal fracture. This rock disintegrates into a brownish silt to clay soil, usually only a thin layer covering

the rock. Cedar occurs also on the "glady" limestone areas on the north-front slope and in the few limestone basins of the plateau interior.

SOILS IN GENERAL.

The soils of the Boston Mountain Plateau vary in texture from clays to sands. The dominant soils are sandy loams, loams, clay loams, and clays. The clays lie on the shale beds and occur most abundantly, therefore, along the north-front slope, on the various valley-side benches, and on the plateau surface. The latter manner of occurrence is most common in the eastern part of the plateau. The shale beds have outcrops in larger areas in the eastern part of the plateau, so that the larger areas of clay soil are north-front and eastern features. Shale beds occur in the western and central parts of the plateau also, but with the exception of one thick bed forming the main mountain-side bench, they seem to be thinner here than in the eastern part. It is possible that the smaller proportion of smooth plateau surface in this section and the greater proportion of slope have made the clay beds less effective areally as soil formers by limiting their outcrops to slopes. In such positions the shale outcrops occur as narrow belts along the slopes. The soils from them are not conspicuous.

The sandy loams and loams occur in belts and areas in the eastern part of the plateau and in larger areas in the western part. They are often stony and are usually fine, rather than coarse, sandy loams. It is probable that mechanical analyses of most of these soils would show that they should be classed as loams rather than sandy loams. Sand occurs practically over the whole area of the plateau and the clay soils usually have an inch or two of sand overlying them. The sandy soils also usually have a considerable proportion of clay in their subsurface and subsoil. Sandy soils predominate along the whole southern border of the plateau. Shale beds are exposed, but the smooth surfaces of considerable size are underlain by sandstone. Mountain-side benches are of rare occurrence; hence the clay beds have very little opportunity to express themselves. They occur in saddles along the ridge tops and in a few small ridge-top areas. Practically all these soils are gray on the surface, yellow in the subsurface, and red below 24 inches. Only occasionally does the yellow subsurface color persist downward.

Silt soils occur on the flat plateau surfaces, on the limestone areas of the north-front slope and interior basins, and in the red-cedar areas of the southern slope. The plateau-top areas are usually the leached areas of shale-derived soils where the clay constituent has been washed down into the subsoil. The limestone soils are silty clay soils, and, like the others, have heavier subsoils.

True sands occur very rarely only in places where the clay and silt, normally found associated with the soils, have been washed out.

SOIL COLORS.

The predominant soil color is gray at the surface, becoming yellow a few inches below the surface. Below the yellow layer the subsoils are red. Second in importance of the soil colors is probably yellow, followed by red, brown, and black. The surface inch or two of soil is almost universally gray. Beneath this the yellow appears. Along the roadways the yellow is made more prominent by the grinding of the soil into powder, the powdered soil being more yellow than the soil in place. On the flat areas the grays are much more prominent, especially where the drainage is incomplete. The coarser sandy soils are usually gray, often, however, with a tinge of yellow.

There are no red surface soils in the Boston Mountain Plateau and brownish reds occur in very few places. Yellowish red is, however, a common color in the clay soils. The clay benches and much of the clay upland surface soil of the plateau has a very pronounced yellowish-red, or possibly reddish-yellow, subsoil and subsurface. On the clay bench lands this is practically universal.

There is a narrow belt of brownish-red soils along the north-front slope in the northwestern part of the area. They are loams derived from a calcareous sandstone.

The brown soils occur most abundantly on the high ridges and hills of the central hill belt of the plateau. They occur also in other parts of the area, usually derived from the medium-grained sandstones. This is especially true of the thin-bedded sandstones of brown color which disintegrate into the so-called black and the red gravelly land.

The brown soils of the high ridges and hills have a reddish cast, with less prominent yellow, while the lower lying brown soils are more apt to be yellowish brown, except the reddish brown and brownish reds referred to above, and isolated occurrences on the northward slopes elsewhere. The walnut and locust land is dark reddish brown wherever it occurs. The silt soils derived from the limestone beds of the north front-slope and the interior basins are reddish brown, but lighter in tone than the sandstone soils of the same color.

There is only one belt of black soils in the region. This is the soils of the north front-slope belt that have been derived from the thick black shale beds occurring there in association with thin limestone beds.

THICKNESS OF THE SOIL MATERIAL.

The soil layer is of moderate depth only. Bedrock outcrops frequently, and even on smooth areas the depth to the rock is usually from 2 to 6 feet. The rock can usually be seen in the roadside ditches. True hardpan is of very rare occurrence on the plateau. It probably does not exist. On the flat clay and silt surfaces the tougher subsoil is sometimes called hardpan, but it is not hard as a rule and is not impervious—is neither hard nor acts as a pan. The shallowness of the soil, however, makes a great deal of it susceptible to drought.

SOIL GROUPS.

On account of the extreme roughness of the country and the time that could be given to the field work it was found impossible to separate and map the distribution of each soil type. Both the differentiation and the mapping can be done in such an area only by means of detailed field work. The character of the soil in this region is not the main determining factor in the character of the agriculture. That is and will be controlled to a much greater extent by the topography.

The soils of the Boston Mountain Plateau, not including the lowlands, lower plateaus, and ridges of the Ouachita region along the Arkansas River, are predominantly Fayetteville soils. Associated with these are Henceville soils and two groups which have been designated as Jamestown and Winslow.

FAYETTEVILLE SOILS.[1]

These are typical plateau top soils, though they occur in the Ouachita region south of the plateau and to a limited extent north of it. They are grayish to grayish-yellow soils, with yellowish, brownish-yellow, grayish-yellow, and reddish-yellow subsoils. They are derived from gray and yellow sandstones and sandy shales. They occur on practically all the smooth surfaces of the plateau, being therefore more abundant in the eastern than the western part. They occur also in patches on the extreme northern border of the belt, as well as in and beyond the southern border. Their range is wider and their area much greater than that of the other plateau soils.

The principal types occurring in the region are loams and sandy loams, usually stony.

The tree growth consists of mixed oaks, mainly black oak, with a considerable proportion of white and red oak, some post oak, and, on the south slope, a considerable percentage of blackjack oak. The latter is confined mainly to the southwestern portion. There

[1] Includes in this region stony loams and silt loams. A lowland phase of this group is described in the discussion of the Ouachita Mountains.

is on the plateau a small quantity of hickory and, within the pine area, of pine. This is also the favorite habitat of the chinquapin.

These soils are easily cultivated, when not stony, but are not highly productive. It is unfortunate that the crops to which they are naturally adapted—cotton and vegetables—can not be grown, except in a few localities, the former on account of the climate, the latter because of a lack of transportation facilities. In the eastern end of the plateau cotton can be grown on these soils, the elevation not being high enough to prevent the proper maturing of a crop. In the southwestern portion, also, where the plateau is low, cotton can be successfully grown, and there is a considerable small-fruit and vegetable growing industry with satisfactory results. On the top of the plateau, wherever these soils are cultivated at all, the ordinary grain and forage crops are grown on them, but the yield, except in wet years, is very low. Apples do not do well, partly on account of the soil and partly on account of the climate. The soil does not grow trees well. Spring frosts occur as late as they do in central and northern Missouri. Where the surface is level and air drainage poor—areas where the large bodies of this soil occur—these frosts are destructive. The trees bloom early, on account of the low latitude of the area, while its elevation makes spring frosts as destructive as in country much farther north.

Hanceville Soils.

These are gray to brown soils, the gray color reaching often to a depth of only a very few inches. The subsoils are deep yellowish red in color and clays in texture.

The type usually occurring in the plateau region is the clay loam or clay. The soil to a depth of an inch or two is a sandy loam underlain by a heavy yellowish-red clay. It is derived from the clay shale beds which occur abundantly in the region, though there are no large areas in which the typical soil occurs. The shale beds outcrop along the slopes mainly and in narrow belts. In the eastern end of the plateau there are a few occurrences of this soil on the smooth plateau top and occasional areas elsewhere.

In some areas mapped as Hanceville the red color of the subsoil occurs only at considerable depth. In such cases the soil approaches the Fayetteville silt loam in character. The Hanceville soil is usually more productive than the Fayetteville, except where it has poor surface drainage.

Winslow Soils.

The Winslow soils are dark reddish brown in color in the upper few inches to a foot or more, underlain usually by brighter reddish brown subsoils. Locally the subsoil may assume a grayish-brown or yellowish-brown color. The soils occur on slopes and are, there-

fore, well drained. The native trees are red oak, black oak, walnut, locust, pawpaw, redbud, hackberry, ash, and an occasional elm; there is also a riotous growth of vines. The soils are derived from brown sandstones and brown shales, mainly the former.

These soils occur in relatively small areas, mainly west of the longitude of Clinton. They range in altitude from about 1,700 to 2,300 feet, but are more frequent in occurrence at the latter elevation. They are mainly phenomena of the higher parts of the plateau. Their main area of occurrence is that of the high ridges in the area of the central belt of the plateau. Where they occur outside this area they are exclusively northward-slope phenomena. Within it, however, they occur on slopes facing to all parts of the compass, though most abundant on northwardly facing slopes.

They seem to be the most fertile of the sandstone and shale soils of the higher parts of the plateau. They are second in fertility to the limestone and calcareous sandstone and shale Jamestown soils of the north front slope.

The types of the series represented in this area are the gravelly sandy loam, the stony sandy loam, and possibly a gravelly and stony loam. The stony sandy loam is of most common occurrence. Practically every area of it lies on a slope and prevailingly on a northwardly facing slope. Many of the slopes are entirely too steep to cultivate and most of them are so steep that the operation of farm machinery, except the simpler kinds, is difficult. This makes the growing of small grains impracticable. The soil produces moderate crops of corn and would probably also grow clover. It would certainly grow clover luxuriantly if lime were applied. This may not be necessary, however. The yield of corn is not high; probably 40 bushels is the maximum.

This is the best of the plateau soils for apples. It is fertile enough to grow good trees, its elevation insures an air temperature favorable to the best development of the fruit in this latitude, the climate has an abundance of sunshine, and the occurrence of the soil on slopes, and especially on northwardly facing slopes, reduces the danger from late spring frosts to a minimum for the region. The north-slope position tends to retard the blooming period and the existence of the slope insures good air drainage. The apple grower can not, however, count on immunity from late spring frosts, even on the most favorably situated of these soils. The northward slopes are undoubtedly the most favorably situated of all, but their position exposes them to the occasional cold waves from the northwest. These are rare, but they happen occasionally, and the apple grower will have to count on their possible occurrence in any year.

These soils lie, as stated above, mainly in the western half of the plateau belt. This part of the belt is crossed from north to

south by the main line of the St. Louis & San Francisco Railroad. A branch of that road runs southeastward from Fayetteville for 50 or 60 miles well into the plateau belt, making it possible to ship winter apples from a considerable portion of these lands.

Small areas of these soils are well distributed over the central and western part of the plateau region. They are much more frequent in their occurrence than the map indicates. They occur typically as narrow benches and slopes in areas entirely too small to map on the scale adopted. They are well-known soils in the region and have soil characters and native growth so distinct that they can be identified by anyone. The occurrence of black locust, walnut, and pawpaw, and the dark-brown color of the soil serve as bases for their ready identification.

Jamestown Soils.

The Jamestown soils as mapped in this area include: (1) A dark-gray to black clay soil derived from thick beds of black shales which occur in association with thin limestone beds. In the bureau nomenclature these soils belong in the Leslie series, but in the present survey they were not differentiated from the other soils with which they are associated. (2) Associated with these heavy black soils are brown to reddish soils with reddish-brown subsoils, derived from a series of chert-free limestones. They grade into the dark Jamestown soils on the one hand and into the Dekalb or Hanceville on the other. These soils belong in the Crawford series of the bureau's nomenclature. (3) A brown to reddish-brown soil with usually a rather bright red to yellowish-red subsoil. It approaches the Winslow soils in color and tree growth, but occurs in association with the limestones of the Jamestown belt. This series is derived from calcareous sandstones and sandy limestones. It occurs mainly in the western part of the Jamestown belt, being developed typically in the vicinity of Boonsboro, Dutch Mills, and Evansville. The darker, more sandy types of these soils are essentially the same as the corresponding types of the Winslow soils.

THE AGRICULTURAL REGIONS.

The distribution of each of these soil groups is extensive. The region has been so thoroughly cut to pieces by the drainage that no one soil type can occupy any considerable area. Over large areas each type occurs as merely a narrow strip on the steep valley sides. Evidently the detailed mapping of such areas would require a great deal of work in locating boundary lines and a large-scale map on which to plot them. To complete such a detailed map would require

many seasons of careful work. This has not been given to it and can not be given to it for some time to come.

There are certain areas, however, in which certain soils predominate. An area in which a certain group of soils predominates is usually characterized by a particular type of topography and native vegetation and, therefore, a certain uniformity of agricultural conditions. While, therefore, it is not possible to map the distribution in detail of each soil type, or even of each group of soils, it is possible to differentiate the Boston Mountain Plateau into several smaller areas, in each of which a certain group of soils predominates. The region has been differentiated into five subregions. The basis of the differentiation is topographic, but at the same time it is intimately related to the soils, as will be shown below. The subregions are as follows: (1) Region of plateaus and steep mountain slopes; mountain bench lands relatively unimportant. (2) Region of narrow mountain benches and steep mountain slopes; plateau lands unimportant. (3) Region of high ridges and narrow benches; plateau lands unimportant. (4) Region of north frontal slope and adjacent lowland. (5) Interior lowland basins.

Region of Plateaus and Steep Mountain Slopes.

The plateau and steep mountain slope region lies in the extreme eastern part of the plateau belt mainly, in the lowest part, therefore. As a rule the mountain slopes are too steep to cultivate. They have no well-defined benches along them. The shales which outcrop and form benches on the slopes of the western part of the plateau belt are on the plateau top in the eastern part. The tillable area is relatively smooth land, either flat, undulating, or gently rolling. The top of the plateau does not lie at a uniform level, but consists of a series of small or narrow table-land strips with a general northwest-southeast trend, the most easterly one being the lowest and the most westerly one the highest. The slope from one of these belts to its adjacent one on the east is steep, the descent varying from 10 to more than 100 feet. The soils of this area are mainly the Fayetteville loam, sandy loam, and silt loam.

The Fayetteville is typical as a rule, though in places the subsoil has a paler color than the typical soil. The best of the several varieties occurring is a soil more nearly brown in color than the typical, with a subsoil somewhat redder than the typical. It is designated by the farmers as "black" or "red gravel land," according to the color of the small stone fragments occurring in it. Where they are dark-red to nearly black ironstone concretions or fragments of sandstone, it is designated as "black gravel land," otherwise as "red gravel land." Both phases are better than the grayer phase of

corresponding texture. These soils are very similar to the Cedar Valley soils of the Ouachita region south of the plateau.

Although this portion of the plateau contains a larger percentage of tillable land than any other of equal size, only a small part of it has ever been cultivated and a smaller proportion is cultivated now than was the case formerly. Abandoned fields and abandoned houses are common. None of the land, or at least a very small part of it, is properly cultivated.

Region of Narrow Mountain Benches and Steep Mountain Slopes.

The Region of Narrow Mountain Benches and Steep Mountain Slopes lies chiefly along the northern border of the plateau, not, however, extending to the northern boundary, and in places in the southern part of the area. In the latter the mountain-side benches are few in number and inconspicuous as a whole. Their main area of occurrence is in the northern part of the plateau. They are best developed along the northern frontal slope and high on the slopes of the deep valleys along which the northern half of the mid-section of the plateau is drained into Buffalo Fork of White River. They are especially well-developed features along all the larger creeks in the stretch extending from Bear Creek on the east to the West Branch of Buffalo Fork on the west. There are three levels along this stretch favorable to the development of valley-side benches that are not too steep for cultivation. The uppermost is developed on a bed of shale lying just above the lower massive sandstone beds of the Boston Mountain series. The shale lies some 300 feet above the highest (Kessler) limestone bed of the limestone-shale rocks of the Jamestown group of soils. It consists of a bed of black shale, with a maximum thickness of 300 feet or more, being best developed apparently in the White River drainage basin and becoming thinner eastward. It does not form well-defined benches along the north frontal slope east of Bear Creek in Searcy County. Whether this is due to a thinning of the shale bed or to its rise to the top of the plateau has not been determined. There is some evidence that the latter is the case. The massive sandstone lying beneath this shale bed forms the shelf—the foundation on which the bench has been developed by the more rapid weathering of the shale bed.

The subsoil is derived from the shale usually, and the soil is derived from sandy material washed down from higher sandstone slopes.

The intermediate bench is developed on the shale beds lying just above the alternating limestone and shale beds of the Jamestown soils. These shales are black or gray, weathering, when occupying a position with good surface drainage, into a gray soil with reddish clay subsoil. In the upper valleys of the White River Basin, where

the rise of the valley floors has reached the level of this shale bed, there is usually a broad basinlike area developed on the shale which lacks, in part, good drainage. The soil in such places is cold, gray to bluish-gray in color, and poorly drained. In such cases the slopes rising above the benches recede so far that the soil is unmodified by the material creeping and washing down from them. On the true benches, however, the soil is made up to a considerable extent of the wash and creep of material from above. This is true of the upper bench as well. In such cases, especially on northward slopes, the soil is often a rather dark-brown sandy loam supporting a native jungle of pawpaw, redbud, walnut, black locust, grapevines, etc. The heavy limestone beds beneath this shale form the shelf on which the bench is developed.

These are the two well-defined and true benches of the Boston Plateau. The lowest one mentioned above belongs, at least topographically, to the Ozark Dome, and the massive cherty limestones supporting it belong with that origin. At the north foot of the plateau slope it forms a fringe of soils that extends northward in tongues along the ridge tops as a veneer of stone-free material overlying the stony material of the underlying limestones. It is the fringe of plateau soils lying on the Ozark Dome heretofore referred to. It does not form a bench or shelf along the Boston Mountain front, as the others described above, since it can occupy such a position only along the valley sides within the plateau when they have been cut through the plateau sandstones and well into the underlying limestones of the Ozark Dome formations. These benches, therefore, are merely narrow strips of the Dome upland that extend up into the plateau where deep valleys have been cut back into it and excavated to a greater depth than the Dome level. The soil on the lower bench is, however, derived from Boston material. The shale and sandstone materials from the higher slopes have been washed and have crept downward and lodged on this bench, covering, as a rule, all the Ozark material completely.

These benches are all narrow, averaging probably not more than an eighth of a mile. They are not flat, but usually slope steeply with the slope of the mountain, usually too steeply for the use of any but the simplest agricultural machinery. Their longitudinal profile also is far from level, due to the cross ravines down which passes the drainage from the higher valley slopes, and also to the accumulated effect of countless landslides that have descended from the higher-lying slopes and lodged on them. The result is a very uneven surface, resembling, in many cases, that of a frontal moraine. Such surfaces exist, of course, only where the higher slopes are steep. The slant of the benches, however, is practically universal.

They are very difficult of access. They lie several hundred feet above the valley bottoms or above the lowland on which the plateau block stands, on the one hand, and far below the top of the plateau above. There are no railways or market towns on top of the plateau, so there is very little occasion to climb up to it. The benches and their occupants stand facing the lower-lying plateau to the north. Markets must be sought in this direction and thence must supplies be brought. There are no well-built roadways up the mountain side to these benches, and the expense of building and maintaining them would be very great compared with the value of the products transported over them. At present they are reached by so-called roads, almost impassable for vehicles without loads. After the bench levels are reached there is often a passable but rarely a good road running along them.

The soil is often productive, but the difficulty of cultivation, due to the slope, the unevenness of the surface, and the abundance of stone, combined with the still greater difficulty of access from the outside, make their utilization difficult. The size of the farms is not sufficient to enable the farmers to engage in livestock farming to any important extent. There is no possibility of making profitable grain farms out of them, and the same could be said, with only very slight modification, of hay farming.

Commercial truck growing is impossible, because of lack of market, and the same may be said of small and tender fruits, because of the distance from and the lack of good roads to the nearest railway shipping points.

Under existing conditions, and conditions that will probably continue to exist for many years to come, there seems to be but one way to improve the condition already existing. This lies in the extension of apple growing. The soil will grow good trees, especially where it consists of a brown loam to sandy loam with a clay foundation. The elevated position and the sloping surface of the benches insure good air drainage and a minimum of danger from late spring frosts—a minimum for the region, but still not complete immunity by any means. Apple growing can not be engaged in on a very large scale because of the small areas of these lands, but it furnishes a means by which the resident farmers may increase their incomes materially.

The soils of these benches are Hanceville clay and loam, Winslow loam and sandy loam, and Fayetteville loam and sandy loam. The subsoil or substratum is in practically all cases made up of Hanceville material, though it may be too deeply buried to be reached by the growing plant.

Abandoned farms exist on these benches, but they are not as familiar a feature as they are on the top of the plateau.

There is very little cotton grown on them. They lie practically at the most northern latitude at which cotton can be grown in the Mississippi Valley. In the valley bottoms it is grown more than on the benches. The elevation of the benches and their occurrence on northward slopes is equivalent to placing them in a position north of the State line climatically. This renders cotton growing difficult.

Region of High Ridges and Narrow Benches.

The region of high ridges and narrow benches is the region in which Winslow soils occur. It, however, includes not only the Winslow soils, but also other soils associated with them. It will be noticed that the main area lies in the west-central part of the Boston Plateau, being practically continuous along the axial belt, but discontinuous on the borders and at each end. It is the highest part of the plateau and the part most thoroughly dissected. It has no considerable areas of smooth land, but this is compensated to a slight extent by the fact that its slopes are not, as a rule, so steep as those occurring elsewhere in the plateau, and especially those along the main valley sides.

The individual beds of rock are thinner and alternate oftener within a given length of slope than elsewhere. The shale beds form benches as elsewhere, and the sandstone beds form steep slopes between benches, but both features are on a much smaller scale than on the mountain sides. The benches are narrow and the difference of level between adjacent benches is less. The whole slope, including both benches and steeper slopes, is often cultivated, though the percentage of cultivated land is small. The percentage of tillable, or at least of land that can be tilled or converted into pasture, is greater than in the bench-land region and somewhat less than in the plateau region. The soil is more fertile, as a whole, than that in the latter region and about the same in fertility as that in the former.

The soils are the Winslow loam and sandy loam, the Hanceville clay loam and loams, and the Fayetteville loam and sandy loam.

The Winslow soils are the most characteristic and are of wide occurrence in the region. Their relative area, compared with the others, can not be stated; apparently, however, it is second to the Fayetteville. They are the most fertile of the soils, but they occur invariably, or nearly so, on slopes. The tillable area is generally within the region too rough to cultivate with complex machinery. It is essentially a region for one-horse and one-man implements and therefore one that can be operated only on a small scale. The possible income per individual is small and will always remain so. It must be a region of small one-man or one-family farms, each owned by the one occupying it. This is true of all the soils of the region and of whatever system of agriculture may be developed.

Next to the Winslow soils in fertility lie the Hanceville soils, and these are followed by the Fayetteville. Practically all the soils are strong; more so as a rule than the soils of the other regions of the plateau.

The relatively small proportion of tillable land, the difficulty of cultivating what is tillable, the low yield, the difficulty of access, and the distance to markets limit very greatly the agricultural possibilities. The conditions, all in all, are very similar to those in the bench-land region. The limitations are much the same, though the difficulty of access is not altogether so great. Since they lie on top of the plateau movement is not restricted within such narrow limits, yet the roads are very poor; they must follow the ridges, and must therefore wind so as to greatly increase the distance from place to place. They will be uneven, because the ridge tops are far from level, and will be very hard to keep in repair because of washing by the rather heavy rainfall. The adaptabilities of the soil are very much the same as that on the bench lands. There is more pasture land, however, so that the possibilities for live-stock farming are greater.

This and apple growing or general fruit growing in the neighborhood of the railway lines constitute the range of greatest possibilities, though there is no doubt that where the facilities for transportation exist the growing of late potatoes and possibly other late vegetables for the Arkansas Valley markets could be carried on. Farther eastward a considerable local potato-growing industry, producing late potatoes for the markets of Clarksville and vicinity, has been developed on the plateau about 10 miles north of that place. In all probability this industry could be extended to other vegetables. Plateau-grown potatoes, when matured late in the season, will keep longer on the lowlands of the Arkansas Valley, it is said, than those grown on the lowlands.

The Winslow region lies at too great an elevation for the growing of early potatoes or other vegetables. Cotton can not be grown for the same reason.

The conditions for the growing of apples in small home orchards seem to be favorable. This has been discussed under the description of the Winslow soils and also under that of the bench land, and need not be repeated here. The climatic conditions here are somewhat more favorable, it would seem, than in the latter area, and the soil conditions are essentially the same.

Region of North Frontal Slope and Adjacent Lowland.

The Region of North Frontal Slope and Adjacent Lowland includes two belts of soil. The southern is the Jamestown belt and the northern is the silt loam belt of the Fayetteville soils. The latter lie

along the northern border of the region below the plateau level and for the most part at the level of the Ozark Dome surface. It is, in fact, a Fayetteville veneer on the top of the Springfield soils. None of it lies on top of the plateau, the southern boundary of the belt in its highest positions lying several hundred feet below the plateau top. It occupies a strip along the usually steep northward slope and spreads out northward as an apron at the foot of the slope. The belt is narrow and practically continuous in its eastern end, broken and patchy along its middle section, and broad at its western end—so broad, in fact, that it loses its beltlike distribution. In the eastern and central parts of the area its width is relatively uniform. Its southern border does not extend southward into the valleys, and its northern boundary does not extend far out onto the Ozark Dome. In the western part, however, both boundaries wander far from a direct course. The southern runs far up into the valleys and the northern far to the northward. In the eastern part of the belt it is, from the point of view of its soils as well as of its rocks, twofold, or has two subbelts—a northerly one of sandstone with some shale and a southerly one of shale. The northerly area is unusually rougher, more stony, and less fertile than the southerly one. In the extreme easterly part of the belt White River has occupied it for some distance, excavating and then building the Oil Trough Bottom, obscuring the original features and changing economic relations.

The shales, where well weathered and where they are not in close association with some of the limestone beds, weather into yellow to reddish-yellow clay soils or typical Fayetteville soils.

The sandstones weather into a gray to yellow loam to fine sandy loam, often rather stony and of only moderate fertility. The upper subsoil is the typical yellow subsoil of the Dekalb series, but the deeper subsoil is the red of the Fayetteville. It is cultivated only where it lies well. Not as much of it is cultivated now as in the past, much of it having been abandoned during the last 10 years. The yellow color is not usually noticeable on the surface, except in plowed fields. It is a general farming and cotton soil, needing humus badly.

The belt ceases to exist, except as isolated areas, west of the eastern area, but becomes again important in the southern part of Boone County. Across this county and the eastern part of Carroll it is of considerable importance. West of this there is another stretch from which it is absent, reaching to the vicinity of Hindsville in Madison County. West of this there is a continuous belt along the foot of the slope of the plateau and also considerable areas north of it.

By reference to the map it will be seen that the northern boundary of the Boston soils turns sharply northward immediately west of the Buffalo Fork of White River. It runs northward to Harrison

and thence west and northwest nearly to the State line north of Green Forest. It then turns sharply south and maintains this direction to Huntsville, where it turns westward again. The boundary line of the plateau runs west from the latitude of Harrison, rather than northwest, by Carrollton and Green Forest, lying just south of both those places. From the latter place it turns south to Huntsville. All the space between the northern boundary of the Boston soils and that of the plateau is a region of gray soils seemingly derived from shales and fine-grained sandstones. They are somewhat heavier, occupy a smooth surface, and are better cultivated than the same group of soils farther east.

Those areas of this soil occurring west and northwest of Huntsville have been mapped by the bureau in the report on the Fayetteville area as Clarksville silt loam. It occurs north of the plateau boundary, on smooth land, except for such areas as have resulted from washing down the slope. It is a gray silt with a grayish to yellowish-gray silty clay subsoil. It is only moderately fertile, though by far the greater part of it is in cultivation. This is due to its occurrence on a smooth surface and to its usual freedom from stone. It grows apple trees fairly well and when well drained it grows them well. A large part of the area occurring near Bentonville is used for apple orcharding and, where the trees are cared for, with fair success. Spring frosts do considerable damage, however.

The Jamestown soils occur in a narrow belt lying on the front slope of the plateau, consisting of several soils, as shown above. None of these, however, seem to occur typically between Jasper and Huntsville, so far as known. A narrow mountain bench occurs in places within this stretch, but neither the black shale nor the limestone were encountered in areas large enough to permit the formation of typical soil. The rock, if it occurs of normal character and thickness, is covered with creep from the sandstones belonging higher up. The soil therefore is merely modified sandstone and shale soil as a rule and often assumes the character of the Winslow loams and sandy loams. Possibly typical Leslie occurs, but the areas are small and on steep slopes.

West of Huntsville true Leslie and Crawford soils have a very limited distribution. Crawford soils occur in small areas in the wide, open, basinlike valleys of the West and Middle Forks of White River and in larger areas farther west, reaching their most typical development in the vicinity of Boonsboro (Cane Hill). Here they lie not on the steep north front slope nor on the lowland north of it, but on top of the first frontal terrace of the plateau. The rise from the lowland to the plateau all along the front from Huntsville to the western line of the State does not take place in one single rise, but by successive rises with terraces between. The Boonsboro area lies

on the terrace above the first rise from the north front lowland. The Crawford soils in the valleys mentioned above occur at corresponding elevations and usually on terraces. They may or may not be well developed and typical Crawford, and it is also true that typical Leslie soils are likewise not abundant in this stretch from Huntsville to the State line. The Crawford soils usually assume the sandy phase described above, and are derived from calcareous standstones as well as from limestones. They are more abundant, however, than typical Crawford. They occur in small areas well distributed along the front from Huntsville to Fayetteville. On the slopes south of Fayetteville in the valleys of East, Middle, and West Forks of White River they occur rather frequently, especially on lower West Fork below West Fork station. West of this the area of occurrence is not larger.

In the neighborhood of Huntsville the most easterly occurrence of the sandy or Boonsboro phase of the Crawford soil is found. It is bright red to brownish red, occasionally becoming dark brownish red in the soil, with a subsoil of the same color. It occurs on slopes steep to gentle and on rolling land. It is derived from a calcareous sandstone, usually medium to coarse grained, massive and on weathered faces assuming a pitted surface, the pits being rather large and shallow. The soil is a loam to sandy loam and is very fertile. It occurs first along the Pettigrew road between Huntsville and War Eagle Creek, seeming to be an important soil in the small basin lying to the west and southwest of the road. It occurs again on the east side of War Eagle Creek and probably occurs in patches along the sides of the broad, basinlike valley of that stream as high up as Aurora; possibly farther. Between Huntsville and Fayetteville it does not seem to occur. The limestones occur along this belt, but rarely do more than modify favorably the otherwise typical Fayetteville soils which occur associated with them. The Crawford soils may, in fact probably do, occur in small areas, but were not met with. The hill on which Fayetteville stands seems to be capped with this soil and it is known to occur in other places in the valleys of the several forks of White River. It occurs in the Boonsboro region also and in a number of places northeast and south of Evansville. It is somewhat more fertile than the Winslow soils and possibly better than the typical Crawford. It washes rather badly on account of its occurrence on rather rolling land.

Interior Lowland Basins.

The Interior Lowland Basins are few in number and unimportant from the point of view of area, but important from the point of view of their agricultural products and the prosperity of the few farmers who are so fortunate as to occupy them.

The most important of the basins are "The Richwoods" of Stone County and the "Limestone Valley" of Newton County. There are two or three others that are unimportant or relatively so.

The Richwoods.—The Richwoods region is a long, narrow basin lying inclosed by the high land of the surrounding plateau, except where the branch of Little Red River, which drains it, effects an exit through a narrow water gap in its southern rim. It lies about 3 miles south of Mountain View, with its longer axis in a northwest-southeast position. It is drained by Turkey Creek into the Little Red River drainage and opens by passes into the lowland north of the plateau on the north and into the head waters of Devils Fork on the east. It is irregular in outline, with an average width of less than a mile. Its floor lies about 350 feet below the top of the surrounding plateau and about 1,000 feet above sea level. The surface is uneven but not rough. It is a lowland basin and not a stream valley, though a small stream flows through it. The slopes surrounding it are as a rule rather gradual. The rocks underlying it are the limestones and shales which form the Leslie and Crawford soils. The rocks of the highlands inclosing it are the sandstones and shales forming the Fayetteville and Hanceville soils.

The soils within the basin are mainly Crawford, except around the border, where there is often a considerable amount of colluvial Fayetteville material. The limestone from which the Crawford soils are derived is, as it occurs in the basin, seemingly nearly 100 feet thick and rather massive, so that a not inconsiderable portion of the basin consists of nearly bare limestone surfaces or "glades," the rock deeply and coarsely pitted, and the surface covered with a good growth of cedar trees. The soils are brown, reddish-brown, to dark reddish-brown silts and silty clay loams. They are productive and fairly well improved. They are all in cultivation, but the farm improvements and equipment do not seem to express as fully as they should the fertility of the soil. This may be due to nonresident ownership, many of the farms having the earmarks in all respects of tenant farms.

It is an area of grain and hay farming. There is no possibility of any form of specialized farming that would require frequent and rapid marketing of the products. The basin lies too far from a shipping point when both distance and character of road are considered. It must remain as it is at present, at least for some time to come, a corn, wheat, and clover region. It produces all these crops fairly well and would produce them still better with more systematic rotation, cultivation, and manuring. The soil does not need doctoring. It needs exercise (cultivation), a change of occupation (rotation), and a little more frequent feeding or manuring.

Leslie soils occur in small areas in the basin, but do not constitute a large proportion of it. Where it occurs it has its usual characteristics. Fayetteville soils occur in places around the border. In such places the fertility is not equal to that of the rest of the basin.

The contrast between the topography, native vegetation, rocks, soils, crops, and farm conditions in the basin with these features in the plateau surrounding it is very striking. It is a veritable oasis and deserves, more by contrast than by actual productivity, all the fame that it has acquired.

The Limestone Valley.—The Limestone Valley lies in the southern part of Newton County. It is smaller in area, different in shape, smoother in topography, its floor much deeper sunk below the level of the plateau surrounding it, and is surrounded by much steeper slopes. It is not a headwater basin of a stream, but is crossed by a stream of considerable size, having, therefore, two outlets, one up the creek, the other down, both outlets being narrow, deep, and wild canyons. It is L-shaped in outline, the basal arm of the L being about 3 miles long and lying in an east-west position, while the vertical arm is about half as long. The average width of each arm is somewhat less than a mile. The floor of the basin is smooth, nearly flat, and lies about 700 feet above sea level. The slopes surrounding it rise steeply to the plateau at probably about 2,000 feet above sea level. Pine Creek enters it from the west, flows eastward along it for about 2 miles, and then turns sharply south and out of it. Some small tributaries of Pine Creek drain its eastern and northern arms.

The soil is mostly Leslie, or that seemed to be the case from the rapid examination that was given it. There is some colluvial Fayetteville around the border and seemingly some sandy phase of the Crawford on low benches. There is possibly some typical Crawford in such positions also. In other words, the soils and rocks are essentially the same as in the Richwoods basin, but the limestone is less in evidence.

Limestone Valley is situated a long distance from a shipping point or a market. Its nearest railway station is Clarksville, in the Arkansas Valley, about 23 miles by direct line and 35 miles by the existing road, which is an extremely rough one. Pettigrew, on the Saint Paul branch of the St. Louis & San Francisco Railroad, is the nearest railway station on the west, about 40 miles by the nearest mountain road. Evidently the difficulties of reaching a shipping point are great. The farming system is limited to stock farming and to cotton growing. The basin is not too high for growing good cotton and its fertile soil gives a good yield. The baled cotton is hauled to Clarksville or Atkins. There is an abundance of range land surrounding the basin, though the growth of grass is not heavy. Stock farming,

however, and incidental grain and forage crops, one of which should be clover, must remain the mainstay of the people.

The Walnut Valley.—The Walnut Valley is merely a local widening of Pine Creek Valley about 5 miles above Limestone Valley and one of its main tributaries, due to the occurrence at the level of the valley floor of the shale and upper beds of limestone occurring in the Limestone Valley. The Walnut Valley is not a basin, however. Its floor is alluvium, with a fringe in places of talus from the higher adjacent slopes, made up mainly of Fayetteville material. The valley does not attain a width of more than a quarter mile. The average being considerably less than that. The soil is the ordinary stony brown loam found in the broader valleys of the region as a whole.

Wileys Cove.—Local valley widening occurs at a number of places within the plateau where a valley bottom lies at the level of a shale bed. One occurs on Turkey Creek a few miles north of Rushing, another on Archies Fork of Little Red River near Copeland, and one on Lee Creek about 5 miles north of Natural Dam. The most noticeable case is that of Wileys Cove on the head of Middle Fork of Little Red River at Leslie in Searcy County. This has widened so far that the mountain wall between it and the Ozark Dome north of the Boston Front has been breached and the cove becomes to a certain extent a feature of the north front lowland. It began and was developed in the same rocks and by the same processes that effected the development of the Richwoods region of Stone County. They are both drained by streams that find an exit from the basins by gorgelike valleys southward. Wileys Cove is surrounded by the basin wall rising to the plateau level, breached not only on the south, through which the drainage finds an exit from the basin, but also by the gap on the northern side.

The rocks in the floor of the cove and in the lower part of the surrounding walls are the limestones and black shales from which the Leslie soils are derived. The topography of the floor is rolling, the true valley alluvial belts within it being narrow. Its area and shape are shown on the map. The soils are typical Leslie clay and loam, with small areas of Crawford, fringes of colluvial Fayetteville, and small areas of gray silts and clays, gray because of thorough leaching. Like all the cove and basin-land soils, it is fertile. It grows corn, wheat, oats, and clover successfully and is favorably situated with respect to a shipping point, the Missouri & North Arkansas Railroad passing through it. The lumber manufacturing industry located at Leslie at the present time creates a good market for milk, butter, vegetables, and fruit. The lumber industry, like all such industries, is a temporary one, dependent upon the supply of timber, which is being rapidly exhausted. Its place will be taken, however, by more

permanent industries and the basin will always be occupied by prosperous farmers on account of the fertility of the soil.

On Frog Bayou, from Winfrey down to the railway, as well as from Frisco to Chester, and on Lee Creek from Ana down by Natural Dam and on to the State line, the valleys widen to more than a quarter mile, and the rocks from which the Jamestown soils are derived, outcrop on the slopes, and their débris influence the alluvial soils to a considerable degree. Topographically, however, they are valleys with level floors (in cross-profile) and not lowland basins with uneven floors. The soil in them is alluvial, usually a brownish to brownish-gray loam, often stony, and usually underlain by a bed of gravel and water-worn bowlders. The crops growing on them are very liable to injury by drought, though the soil is fertile when cared for. The crops are corn and cotton.

THE OUACHITA MOUNTAINS.

LOCATION AND BOUNDARIES.

This report is concerned with that part of the Ouachita Mountains that lies between the Arkansas River and the foot of the southern slope of the Boston Plateau block. It includes ridge and lowland belts typical for the region, and along the northern border a series of plateaus, more or less isolated by lowland belts and areas, essentially like the upland surface of the Boston Mountain Plateau, within Region No. 1, but considerably lower. Their surfaces lie at a maximum elevation of about 1,200 feet. From Scotland eastward to the White River lowland at Searcy there is a continuous lowland belt between these plateaus and the south foot of the Boston Mountain Plateau. South of these plateaus lies the typical belted country with its alternating ridges and lowland belts. The ridges and plateaus are well defined but low, so that the whole area north of the Arkansas River is an area of low relief when compared with the Boston Mountain Plateau, and will be described as such. The area is wedge-shaped, running to a point at the western State line and reaching maximum width at the extreme end, where it abuts against the White River lowland area. The boundary lines are, on the north, the south boundary of the plateau already described, on the south the Arkansas River, and on the east the St. Louis, Iron Mountain & Southern Railway, approximately. It includes about 2,700 square miles.

TOPOGRAPHY.

Topographically the area consists of a northern and a southern part, each having a characteristic topographic expression. The northern part is formed of a series of more or less isolated plateaus, somewhat irregularly placed and irregular in shape, set in the midst of a lowland. The southern part consists of a series of east-west

parallel, narrow ridges, with intervening narrow valleys or low belts, set likewise in the midst of a lowland. The dividing line between the two parts runs from the Arkansas River near the mouth of Little Pine Creek eastward by Mill Creek, Russellville, Hattieville, Springfield, Greenbrier, Mount Vernon, and Antioch to the boundary of the area.

The plateaus of the northern area are rather low and level topped, but dissected, with sharply defined boundaries. The lowland in which they are set is as a rule gently undulating. The slopes from lowland to plateau are usually steep. In other words, the two features of plateau and lowland are clearly defined on the ground and their boundary lines sharply drawn. There are a few exceptions to this. The plateaus do not, however, all lie at the same or even at accordant elevations, but at two rather well-marked levels. The higher plateaus lie at about 1,200 feet above sea level, the lower at about 800 feet, and the lowlands at about 400 to 700 feet. The plateaus do not occur west of Mulberry River, all the area of the belt west of that stream being lowland. Attention was called when describing the southern slope of the plateau to the fact that in this stretch the slope was gradual and there was no well-marked line between the high plateaus and their lower portions farther down the gradual slope, so that the boundary line was drawn at the foot of the slope. Another observer might draw the line farther northward, placing the lower portion of the plateau in the Arkansas Valley lowland.

The eastern end of the region as a whole, east of a line from Russellville to Scotland, consists, topographically, of a narrow lowland along the northern border, the Eglantine-Shiloh-Heber-Searcy belt—the broad plateau lowland belt, as described above—and a southern belt, narrow at the western end and wide at its eastern end, consisting essentially of lowland like the lowland portion of the western end, but broken by a series of low, narrow, but prominent ridges which trend across it in an east-west direction. An occasional plateau occurs in this portion and an occasional ridge in the northern portion. The ridges are often curved, and in some cases two ridges coalesce at either or both ends, inclosing basins. They are straight backed, have few gaps, are rarely more than a quarter mile wide at the base, and rarely more than 250 feet high, more often about 150 feet and lower, the lowest being barely perceptible.

The northern border lowland belt wedges out at Scotland, is about half a mile wide at Eglantine, a mile a few miles below Heber, about 3 miles at Pangburn, and a little wider than that at Searcy. It has a gently undulating surface.

The plateaus are essentially like those of the western portion of the belt in shape, ranging, however, somewhat higher in elevation, the

maximum elevation being probably about 1,400 feet south of Heber. The lowland belts and basins in the southern portion are low and smooth, like those farther west.

DRAINAGE.

The drainage is in general from north to south through a series of large creeks, all of which head well back in the Boston Mountain Plateau, and a number of very much smaller streams rising in the lowland itself. The large streams, excepting Little Red River, maintain rather direct courses across the lowland, while the small ones usually do not. They are unable to maintain a course directly across the east-west ridges which lie in the lowland. Little Red River does not belong to either group, being a large stream which takes an indirect course. It lies along the northern border lowland belt and at the foot of the south slope of the plateau after it issues from the interior of the plateau at Eglantine. It is a large stream that avoids the ridges, following a course along a low belt. These streams, both types, are shown on the map and need no detailed description here.

THE ROCKS.

The rocks of the Ouachita region are sandstones and shales. Not a single occurrence of limestone was found during the progress of the work. The limestone which forms the Crawford soils and takes part in the formation of the Leslie soils of the northern plateau border lies beneath the rocks of the lowland and does not reach the surface at any point within it.

The sandstones vary from coarse-grained gray or white rocks, usually found on the higher plateaus, through finer grained brown or yellow rocks to the very fine grained, compact, reddish-brown to black flaggy rocks from which the Cedar Valley phase of the Fayetteville soils is derived. The latter rocks occur on the lower plateaus and benches, above the lowland areas, and in the ridges. The coarser grained rocks underlie the higher plateaus.

The shales range in character from the sandstone-shale borderland of fine-grained shelly argillaceous sandstone or sandy shale, usually brown, gray, or yellowish in color, down to the black fissile shale, almost sand free. The former are found associated with the sandstones of the plateaus and in narrow belts near the lowland ridges, while the latter underlie the main lowland areas between the ridges.

NATIVE TREES.

The native trees of the plateaus are predominantly blackjack and post oak—blackjack on the sandy land and post oak on the silt and clay land. The rest of the timber is mainly black and red oak, some

white oak, and in places a great deal of pine. The pine occurs as occasional trees over a large part of the plateaus but as pine forests mainly south of Heber within an area bounded by a circular line drawn through Heber, Pangburn, Center Hill, Mount Vernon, Bee Branch, Choctaw, Eglantine, Shiloh, and Heber. The growth in the lower plateaus is black and red oak, hickory, elm, and cedar, with occasional post oak, blackjack oak, and white oak. The ridges farther south support essentially the same trees except the cedar, which occurs rarely, with a larger proportion of white oak and occasional pine trees.

The trees of the lowlands are post oak on the flat lands, with some thorn and other brush, willow oak, water oak, and occasional white oak. On the rolling lands, especially if a little sandy, red and black oak are the predominant trees.

SOILS IN GENERAL.

The rocks of the Ouachita belt are the same as those in the Boston Mountain Plateau. The same beds of sandstone and shale which lie in a nearly horizontal position under the latter lie under the former in part in a horizontal position, but mainly in a series of folds or up bows and down bows, so that the individual layers of rock plunge downward into the earth at angles varying considerably in steepness, often practically vertical. The corresponding beds lie, when horizontal, at a lower altitude in that part of the Ouachita belt included in this report than in the plateau. The lower altitude of all the beds has depressed the lower beds so deep beneath the surface that they are not exposed on the surface at any place in the Ouachita region. This applies especially to the rocks which form the Jamestown soils. These soils do not occur, therefore, in the Ouachita region.

The rocks forming the Winslow soils are exposed in many places in the Ouachita belt, but not in positions favorable to the development of Winslow soils. The reason is probably climatic.

SOIL GROUPS.

Appleton Silty Soils.

The Hanceville soils have not been mapped in the Ouachita region, although there are large areas of soil derived from black shales, probably the same bed that forms the Hanceville soils on the plateau.

The soils derived from this rock in the Ouachita region were mapped as Appleton soils, although their differentiation from the Hanceville is based mainly on their lower elevation and resulting difference in agricultural use, on their topography, which is smoother, and upon a very slight difference in the subsoil. The latter lies in the yellower

color of the upper subsoil of the Appleton. The characteristic red to yellowish red of the Hanceville is found in the lower subsoil of the Appleton. Both the Hanceville and Appleton soils are very much the same in all respects except texture as the Fayetteville and could have been mapped as such.

Appleton Soils.

The area mapped as Appleton soils consists of a series of narrow linear or curving ridges with intervening lowland belts. The latter vary in width from a few hundred feet to as much as 5 miles, the latter extent being attained, however, in rare cases only. The ridges are even topped, rarely more than 150 feet higher than the adjacent lowland belts, usually steep sided, sharp crested, and rarely wider at the base than a quarter mile.

The soil on the ridges is usually Fayetteville stony loam, though on the broader ones it occasionally approaches the soils mapped as Cedar Valley in character. The soils in the intervening valleys are Appleton, Cedar Valley, and more rarely Fayetteville, silt loams and sandy loams as a rule. In the broader lowland belts they are invariably Appleton silty loams, in the narrow valleys rarely so.

The ridges are not cultivated as a rule. The lowland belts are mostly in cultivation and used mainly for growing cotton and corn.

Fayetteville Soils, Lowland Phase.

The heavy sandstone beds weather into Fayetteville soils in the Ouachita belt the same as in the plateau belt. As a rule, however, their subsoils are redder than those occurring in the plateau. This is especially true of the region south of Bee Branch and the vicinity of Guy.

Cedar Valley Soils.

The soils derived from thin-bedded, brown, fine-grained sandstones occur in considerable areas in the Ouachita belt. They have not been mapped in the plateau belt, the nearest approach being the red and black gravel lands in the eastern part of the plateau. These soils have been mapped in the Ouachita belt as Cedar Valley soils. They are brown to grayish brown in color and usually silt loams and loams, rarely fine sandy loams. The subsoils are yellowish red to yellowish brown in color and heavier than the soil.

The soil and subsoil layer, above the undisintegrated rock, is usually thin, often less than 3 feet. Uncultivated areas support a growth of oak and cedar, with smaller representation of many other trees. These soils, when not too shallow, are moderately productive.

A few belts of narrow sandstone ridges and alternating narrow valleys have been mapped separately as ridges of Cedar Valley and Fayetteville soils alternating with narrow valleys of Appleton soils.

The ridges are, as a rule, nonagricultural, while the valley belts between them are narrow, usually only a few hundred feet wide, though the soils are usually Appleton or Cedar Valley soils. The belts are too narrow to be shown on a small-scale map.

The upland soils of the Ouachita belt, that part of it lying north of the Arkansas River, are, therefore: Fayetteville soils, lowland phase; Appleton soils; and Cedar Valley soils. The distribution of the several groups is shown on the map.

Glenn Soils.

A group of gray, yellowish to brownish sandy soils, with yellowish subsoils occurring in a narrow discontinuous belt along the eastern border of the region in Arkansas, has been mapped as Glenn soils. They are derived from Coastal Plain material and mark the extreme inland margin of the original undisturbed occurrences of this material in the Ozark region. They are not typical Glenn soils in every respect, but differ so little from them that the error in associating them with the Glenn is insignificant. They lie along the Ozark margin, usually less than 100 feet above the level of the adjacent lowlands, as a veneer on both the shales and sandstones and the limestones. They were not found on the former rocks, except in places where these lie only a few feet above the lowlands.

The soils are mainly sandy loams and fine sandy loams. The deeper subsoils and the substratum is often red or mottled red and yellow. The drainage is usually rather well established in places, however, on account of the flatness of the topography being deficient. They are used for the production of cotton and corn when used at all and under proper care and cultivation give fair yields, though they can not be considered fertile soils. They are cultivated to a somewhat less extent now than formerly. When they have once been cultivated and later abandoned they wash badly except on flat areas.

Locally the subsoil is a red gravelly clay or silty clay, the soil in such cases being somewhat more productive than elsewhere.

THE AGRICULTURAL REGIONS.

The utilization of the soils is to a great extent a question of location and topography. The region will be described, therefore, not on the basis of its soil areas, but on that of its topographic areas, as in the case of the plateau. These areas are: (1) The Lowland Region; (2) the Ridges; (3) the Intermediate Plateaus; (4) the Higher Plateaus.

The Lowland Region.

The predominant soils of the Lowland Region are the Appleton soils, usually occuring as the silt loam, with considerable areas of

Cedar Valley soils. The surface on which the Appleton soils occur is smooth, nearly flat, relieved by low circular mounds 2 to 4 feet high and 10 to 20 feet in diameter. The soil is gray to yellowish on the surface, changing to a yellow, often a lemon yellow, a few inches below the surface. The subsoil is yellow to grayish yellow, sometimes with a tinge of red when it is coarse grained. It is an easily worked soil as a rule and moderately productive. The crops grown on it are corn and cotton, the yield of corn amounting to not more than a 25-bushel average and of cotton about half a bale to the acre. It is low in humus and lime and can not be made highly productive without the correction of these deficiencies. It can not be made permanently productive by annual dosing with fertilizers. The task requires time and persistent and systematic effort. Fertilizers give temporarily favorable results, moderately favorable at least, but under existing physical conditions of the soil their application is a hand-to-mouth process with the results usually accompanying such methods and with no end in sight.

The flat areas within the Appleton area have gray silt soils becoming yellowish an inch or so below the surface. At about a foot below the surface there is a layer of heavy, sticky brown clay about 6 inches in thickness, beneath which lies a yellowish sandy or silty clay with brown mottlings. The soil and subsoil are essentially the same as that of the Oswego silt loam of eastern Oklahoma, southeastern Kansas, and western Missouri. The trees are mainly post oak, thorn, willow, and water oak. In the "swales" the soil is gray and poorly drained, and covered with a growth of sweet-gum saplings and various water-loving shrubs.

On the low, broad ridges the soil is more sandy as a rule and has usually a much greater proportion of red in its color. In such cases it approaches the Cedar Valley soils in character. It is more sandy as a rule, better drained, and more fertile. The native trees are mainly black and red oak, with a sprinkling of a great many other varieties. These areas occur most abundantly between the narrow ridges of the southern part of the eastern half of the Ouachita belt. In portions of the Searcy Valley belt, especially in the Pangburn-Heber stretch, there are considerable areas of the Cedar Valley phase.

In the more rolling parts of the areas mapped as Appleton, where the typical black fissile shale underlies the surface, the soil approaches the Hanceville in character. It occurs more abundantly in the Searcy Valley belt than in any of the others, and in that chiefly in the stretch west of Armstrong Springs, beyond that part of it known as Searcy Valley.

The bottom lands along the rivers and creeks exhibit two phases—an undrained or poorly drained phase on which water stands a considerable part of the time, and a well-drained phase usually subject

to overflow but draining readily. As a rule the former is uncultivated, the latter cultivated. The former is a gray to nearly black silt to clay, the latter is a brown to gray loam to sandy loam, often stony. The former soils occur usually in the southern, the latter in the northern part of the belt.

A large part of the area of Appleton soils is in cultivation. Where the surface drainage is good it gives fair yields. Where the belts are broad there is a considerable proportion of inadequately drained land which does not produce good yield of any of the ordinary crops of the region, but good yields of hay are obtained from the wild growth of Japan clover. It grows to a height of 12 to 18 inches and yields about a ton to the acre, according to the reports of farmers of the region. A rather small area of country can be expected to give such a yield, however.

The crops grown on these soils are corn and cotton, with small areas devoted to hay and forage crops. Corn will yield 25 to 35 bushels and cotton a little more than half a bale.

As a whole this is the most important upland soil group in that part of the Ouachita belt that has been mapped. It is smooth, cultivated easily, and the yields are fair. Wagon roads are fairly good, and the southern part of the belt railway transportation is available.

The Ridges.

The ridges occur in the southern part of the belt. Their distribution is shown on the map and their general configuration is described above. They are underlain by beds of sandstones ranging from coarse to fine, all standing on edge or inclined at steep angles. The soils are stony loams usually, and practically always uncultivated. The soils are usually brownish in color. On some of the more sloping areas the soil is apt to be a brownish loam with a reddish subsoil—a transition from the typical brown or grayish brown of the ridges to the Appleton soils of the lower areas or the Cedar Valley of the intermediate plateaus.

The narrow belts between the ridges, where they are not more than three-eighths of a mile in width and where the surface is rather strongly rolling, usually contain the reddish sandy soils of the Fayetteville. Where wide enough and smooth enough for cultivation it is covered by farms with better improvements than are found, as a rule, on the Conway soil. It seems to be somewhat more productive than the latter, except where it is very shallow.

The Intermediate Plateaus.

These consist of low plateaus, as benches or terraces around higher plateaus, and as low belts between plateaus, higher, however, than the lowlands among the ridges of the southern part of the area.

Their distribution is shown, in a general way, on the accompanying map.

The predominant soils are the Cedar Valley soils. They are underlain by the compact dark-colored flaggy rock characteristic of such areas. The type locality, so to speak, the Cedar Valley from which the name was derived, lies in this area, in the vicinity of Rosebud, between that place and Mount Vernon. The soil is brown to gray on the surface, with a brownish-red subsoil, but the flaggy sandstone is exposed in many places. Where the soil is thick enough to cultivate and to form a moisture-holding reservoir it is moderately productive—as good as, if not somewhat better than, the typical Fayetteville, especially for grain crops; not more so for cotton.

The native trees are red and black oak, hickory, and cedar, with some white oak and post oak and occasional willow and water oak and thorn.

Associated with the Cedar Valley soils are narrow belts of Hanceville silts and silty clays or their leached gray and more intractable and hopeless associates, the gray silt and clay soils with post-oak tree growth. They are found in areas on top of plateaus, where remnants of a formerly overlying shale bed occur, on plateau benches, where they are due to the outcrop of a shale bed, and in low belts caused by shale outcrops. It is in these low belts, where there is an abundance of moisture, where the soil is gray and the subsoil blue to blue and yellow mottled clay or silty clay, where the tree growth is willow and water oak rather than post oak, that the Japan clover grows to a height of 12 to 15 inches and is cut for hay. It is valued very highly as a feed, especially for cattle. Its growth is not confined to the willow-oak land of the intermediate plateaus, but grows as well in all the other areas where the same soil occurs. It occurs everywhere in the Ozark region, except on the very richest of bottom lands and on the poorest mountain sandy and clay land, but it rarely reaches a greater height than 6 inches, except on the moist lands described above.

Associated with the Fayetteville and Upshur soils on these plateaus and terraces are the Dekalb soils, usually represented by a gray to yellowish-gray phase with a reddish-yellow to yellowish-red subsoil. The types are sandy loam to fine sandy loam and loam. It is the characteristic blackjack land occurring also on the higher plateaus and on the southward slope of the west end of the Boston Plateau where the soil is sandy.

This is the most extensively cultivated of the plateau soils and is a moderately productive soil for both corn and cotton. Like all sandy soils, it is low in humus, but it is not high enough in sand to make it very droughty. Peach trees seem to do well on it, and there seems to be no reason why small fruits should not do well. Spring

frosts are occasionally destructive, however. There is no market at present for the latter crops, except those grown in the extreme western part of the area and on the adjoining one west of it. There has been some attempt to grow apples on this soil, but without success so far as commercial apples are concerned. The trees do not do well, and the fruit does less well than the trees. The soil is too sandy, and the elevation is not enough to compensate for the latitude.

The yield of corn is low, about 20 to 30 bushels per acre, but could be increased by manure and better cultivation. With market conditions such as they are, and will probably continue to be for many years, this soil will be used as it is now—for the growing of cotton and corn, except when the market is near enough to permit the growing of peaches.

The Higher Plateaus.

The distribution of the Higher Plateaus areas is shown on the map. They are isolated, usually roughly circular areas. Their topography is that of a rolling to smooth plain, with valleys cut into it. They are usually sharp and deep around the boundaries of the individual areas, but within they may be open and shallow.

The native trees are black and red oak, blackjack, and pine, with a predominance of the latter two. Post oak occurs sparingly, as does also white oak. Black gum occurs on all the lands of the Lowland belts, but never occurs thick enough to make a forest.

The soils are Fayetteville sandy loam and loam, and smaller areas of gray silt, possibly silt loam. The latter seems to be of rare occurrence, however. The predominant soil is the blackjack soil like that of the lower plateaus, seemingly, however, in most cases a little more sandy and a little coarser in grain.

These areas lie as a rule not more than 300 feet higher than the level of the Intermediate Plateaus. This is not sufficient to make any essential difference in climate. The soils and climate being the same, the crops are necessarily the same also. Where cultivated, the crops are cotton and corn. On the Lutherville Plateau a colony of Germans have been living for many years. They seem to have done more than the average Americans have done on the same kind of land, but the result is somewhat disappointing. Their houses and barns are more comfortable than the average on the same soils, but they can not be said to indicate a degree of great prosperity. There was even an air of neglect, as though the farmers had become satisfied with a very moderate scale of living. Fences were not in the best of order, and fields were uncultivated and left to grow up to brush; houses were unpainted. It seemed to indicate that even the steady-going German peasant is incapable of maintaining an eternal fight against unfavorable conditions where the stimulus from the outside is very low or lacking and when the rewards are very small.

Alluvial Soils of the Ozark Region.[1]

There has been more or less discussion of the alluvial soils in the consideration of each of the upland soil groups. It is unnecessary to add very much to that.

The alluvial soils throughout the Ozark region are predominantly brown to reddish brown. In a few places terraces with gray to nearly white soils occur, but they are of very limited distribution. In the Ouachita region there are considerable areas of gray first-bottom alluvial soils which approach the Holly soils in character, though they are derived entirely from sandstones and shales. They are of about the same agricultural value as the Holly.

The alluvium along all the streams of the Ozark Dome, the Boston Mountain Plateau, and the larger streams of the mapped Ouachita belt which rise in the plateau is of quite uniform color and producing capacity. The soils derived from this material are typical Huntington soils. In the Ozark Dome they are gravelly as a rule, and often redder in color than the typical Huntington. The gravel consists wholly of chert. The subsoils have more red in their color than the soils. The types are not usually so light in the subsoil as some of the alluvial soils of the Boston Mountain Plateau. In the latter region the soils are brown rather than reddish brown, but otherwise are much like those of the Dome region, except that their subsoils are much more porous, being made up in many cases largely of sandstone cobbles reaching the size of bowlders in some cases.

Taken as a whole, the alluvial soils of the Ozark region do not stand drought as well as the general run of the upland soils. The latter have invariably heavier subsoils than soils, while the former are predominantly light in the subsoil. The alluvium deposited by the streams with low current only has a subsoil as heavy or heavier than the soil. Such streams are very few in the whole region, except in parts of the Ouachita belt. Droughts of sufficient severity to cause a total failure of the crop on any of these soils, however, are of rare occurrence. Total failures are practically unknown, and serious injury on soils that have been well cared for is of rare occurrence.

Practically the whole area of alluvial soils in the Ozark Dome and the Boston Mountain Plateau is in cultivation. These lands were the first to be cultivated, and in large areas of country they are yet practically the only soils that are cultivated. In the Ouachita belt there are areas of heavy soils that are frequently overflowed still in timber. In the northern part of the region the alluvial soils are devoted to the growing of grain crops, mainly corn and wheat and of clover and timothy, with a small but increasing average of alfalfa. The better-drained soils will grow alfalfa successfully, providing they are kept in good producing condition.

[1] Mainly Huntington.

In the southern part of the region cotton takes the place of wheat, part of the corn, and practically all of the clover. Some alfalfa is being grown on the White River bottom lands, especially in the Oil Trough Bottom, and to a less extent elsewhere. A field of clover on either upland or bottom land south of White River is a rare sight. The clover belt in the Ozark region is the Dome border belt.

Johnson grass is grown for hay on the southern bottom lands, though taken as a whole very little forage, as such, is produced, except where alfalfa is grown. The small farmer depends almost entirely on the corn blades or "fodder" that he can strip from his corn while it is still green. It is cured, bound into bundles, and stored for winter. A small acreage of oats is grown, some crab grass is cut for hay, and a little attention is paid to sorghum. Cotton and corn are the two main crops. Melons do well and are grown in a small way all over the southern part of the area.

The area of alluvial soils is small, probably not more than one twenty-fifth of the whole area, yet these soils produce a large part of the crops grown in the region—a very large part in comparison with their area. There are no statistics at hand on which to base an estimate, but it can not be far from a fourth of the total—certainly not less than a fourth of the grain produced. In the economy of the region, therefore, these soils are of the highest importance. Under existing conditions they are the only soils in large parts of the region on which profitable grain growing can be carried on. This is especially true of the Clarksville area, large parts of the Howell area, and the rougher parts of the Springfield area. It is true, also, of the whole plateau belt.

It has been stated repeatedly in the foregoing pages of this report that under present conditions large areas of the Ozark region, especially of the Ozark Dome, can be best utilized at present as grazing land, and therefore in the raising of live stock. Although the area lies south of the central latitude of the country, it can furnish no grazing worth mentioning between the first of November and the middle of March. Live stock will, therefore, have to be fed during these months. A large part of the grain for this purpose and an important part of the forage must be grown on the alluvial lands. The ideal farm in the region must thus include a small acreage of alluvial land intensely cultivated and devoted to the growing of grain and the higher grades of forage plants, and a large acreage of the uplands devoted mainly to summer pasture with forage and hay crops on the smoother and more fertile areas. As stated in the discussion of the agriculture of the region, this applies mainly to the central Dome region rather than to the Dome border. It applies also to the plateau, though the growing of pasture grasses on the sandstone and shale soils of that region will be found more difficult than on the limestone lands of the Dome region.

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U.S. DEPT. OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF

SOIL MAP

MISSOURI-ARKANSAS

RECONNOISSANCE SURVEY, OZARK REGION SHEET

UNIVERSITY OF MISSOURI
AGRICULTURAL EXPERIMENT STATION
F.B. MUMFORD, DIRECTOR

LEGEND

Rough stony land (Including soils derived from igneous rocks) — R

Fredericktown soils (Includes Dunning, Hagerstown and Colbert) — F

Dent soils — D

Clarksville soils (Mainly stony loam) — C

Union soils — U

Howell soils (Includes some Clarksville) — Ho

Tilsit soils — T

Hagerstown soils (Including some of Colbert and Dunning) — H

Lebanon soils — L

Iberia soils — Ib

Crawfordsville silt loam — Cr

Berryville soils — B

Inard soils — In

Pocahontas soils — Po

Springfield soils — S

Jacksontown soils — J

Fayetteville soils — Fa
Stony loams

Mainly silt loams — Sa

Lowland phase — Sa

Hanceville soils — Ha

Winslow soils — W

Appleton silty soils — Ac

Cedar Valley soils — Cv

Appleton soils (Including values of Fayetteville and Cedar Valley soils) — Ac

Clenna soils — G

Alluvial soils (Mainly Huntington) — A

Soils surveyed by Curtis F. Marbut

Field Operations Bureau of Soils 1911

6 Miles-1 Inch